Essays on Costs and Benefits of Credit Default Swaps

by

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Declarations

I declare that any material contained in this thesis has not been submitted for a degree to any other university or academic institution.

All work contained in the thesis is my own. I further declare that Chapter 2 of the thesis is co-authored with Dr. Sarah Qian Wang. Chapter 3 is co-authored with Dr. Andrea Gamba and Dr. András Danis.

Anastasiia Lashova
26 September 2019

Abstract

The thesis comprises three essays which reveal previously undetected costs and benefits of Credit Default Swaps (CDSs).

Chapter 2 empirically studies the effect of credit derivatives on employees – one of firms' key non-financial stakeholders. We find that CDSs increase employee compensation for both non-executive and executive workers. The positive effect on the base pay increases with employees' bargaining power and their expected exposure to unemployment risk. Unlike general workers, the growth of CEO compensation is mainly driven by performance-sensitive pay with higher vega in compensation structure. In addition, CDSs improve overall labor welfare due to wider cash profit sharing and enhanced health and safety programs. These findings are consistent with the increased workers' concerns on human capital risk and enhanced interest-alignment between shareholders and employees in CDS firms.

Chapters 3 and 4 shed new light on the effect of CDSs on financial contracting. In Chapter 3, we theoretically examine whether creditors' access to the CDS market changes their incentive to use traditional tools of financial contracting, such as debt covenants, for protection of their interests. We find that CDS-protected lenders can have a lower incentive to include covenants in loan agreements. But the reason of this reduced incentive lies not in the substitutive effect of the CDS market, discussed broadly in empirical literature, rather in its detrimental effect on covenant effectiveness. Our model demonstrates debt covenants as a more universal tool for debt protection, the effectiveness of which in the presence of CDS trading is mainly determined by the probability of creditors to turn into empty creditors and force a liquidation.

Chapter 4 provides strong empirical support for the comparative statics predictions developed in Chapter 3. Unlike covenants, CDSs do not alleviate, but enhance investment distortions created by debt overhang. The investment-distortion effect of CDSs is more prominent for firms with the higher likelihood of the empty creditor threat, such as for the higher amount of CDS insurance written on firms and/or the weaker firms' fundamentals. Further analysis reveals that, in the post - CDS inception, covenants lose their effectiveness as a mechanism against no-commitment. The CDS market undermines shareholders' incentive to undertake valuable investment despite the presence of strict covenants in a loan contract.

Chapter 1

Introduction

The introduction of credit default swaps (CDSs) in 1990s, one of the major and the most controversial financial innovations of recent decades, and the explosive growth of their market had a significant impact on the debtor-creditor relationship. CDSs are credit derivatives providing an effective tool for credit risk transfer. Working similar to insurance contracts, CDSs give lenders protection against credit events of borrowers (e.g., bankruptcy filing, default on payments) in exchange for periodic premium payments. The past decade has seen the rapid development of research, both theoretical and empirical, on the costs and benefits of the CDS market motivated by CDS-related regulatory changes following the Great Financial Crisis.[1] Even though, the CDS market has demonstrated a continuous decline in notional value after the crisis from \$61.2 trillion in 2007 to \$9.4 trillion in 2018, it still remains significant, representing the third biggest over-the-counter derivatives market in the world and leaving never ending debates on the effect of CDS trading on welfare (BIS, 2018). We contribute to this discussion by revealing previously undetected positive and negative effects of the CDS market.

The thesis comprises three essays. Chapter 2 empirically studies the effect of CDS trading on one of firms' key non-financial stakeholders – employees. Chapters 3 and 4 shed new light on the effect of CDSs on financial contracting.

Chapter 2 provides the fist comprehensive assessment of the effect of CDSs on human capital of reference firms. Human capital is increasingly seen as one of the most crucial asset for corporate competitive success (Zingales, 2000). As an important stakeholder of the firm, employees can suffer significant losses when their

[1]The current literature on CDSs is well summarized in a comprehensive survey of Augustin, Subrahmanyam, Tang, Wang, et al. (2014).

employer firms are in distress or file for bankruptcy. Furthermore, employee wealth can be directly affected by corporate debt and investment policies though its effect on performance-based compensation and indirectly through adjusting base pay for changes in overall firm risk. Using a large sample of U.S. firms, we find that the introduction of CDS trading on firms' debt increases employee compensation for both non-executive and executive workers (corresponding to a 8% increase in average employee pay and a 10% increase in total CEO compensation). Using Environmental, Social and Corporate Governance (ESG) STATS data on employee relationship ratings, we find that the effect of CDSs on general employees is associated not just with higher base wages, but also in the form of improvement in overall labor welfare, particularly in broad-based cash profit sharing and health and safety benefits. These results persist even after addressing the potential endogeneity of CDS introduction using propensity score matching, reverse causality test, and instrumental variable estimations.

We identify two channels that drive our results. First, we find that CDSs affect employee wealth, particularly the base part of employee compensation, through workers' inability to fully insure their human capital risk.[2] That we label as the "human capital risk" channel. The growth in credit supply ex ante and probability of inefficient liquidation ex post following the introduction of CDS trading (e.g., see Bolton and Oehmke, 2011; Saretto and Tookes, 2013; Subrahmanyam, Tang, and Wang, 2014) raise employees' concerns on their human capital risk. Consistent with the stakeholder theory (e.g., Agrawal and Matsa, 2013; Berk, Stanton, and Zechner, 2010; Chemmanur, Cheng, and Zhang, 2013; Titman, 1984), we find the increase in general workers' compensation in response to the increased bankruptcy risk post CDS inception. These wage differentials, compensating for increased employees' concerns on human capital risk, represent indirect costs of financial distress paid by firms ex ante. Interestingly, we find that general workers in the average firm with traded CDSs are more concerned about risk of losing their job than executives. In support of the "human capital risk" channel, we find the stronger CDS effect on employee base pay in firms with higher employee bargaining power and greater workers' exposure to unemployment risk.

Second, to take advantage of the relaxed financing constraints and increased lenders' risk tolerance following the introduction of CDS trading (Bolton and Oehmke, 2011; Morrison, 2005; Parlour and Winton, 2013), shareholders of CDS firms have an

[2] Murphy (1999) emphasizes that risk-averse employees would naturally prefer a dollar increase in base salary to a dollar increase in "target" bonus or any other variable compensation.

incentive to further align managers' interests and encourage their risk taking to maximize equity value. That is exactly what we can observe in our results for executive workers, the growth in total compensation of whom post CDS inception is mainly driven by the increase in equity-based pay. We label this as the "interest alignment" channel. In addition to the increased equity-based pay, used to directly link managers' payoffs to a shareholder value (Jensen and Meckling, 1976), we find the increase in the sensitivity of CEO wealth to stock return volatility (vega). Where the increased vega corresponds to a reduction in managers' aversion to take "riskier" policy choices (e.g., in the form of higher firm leverage and more investments in innovation). While the incentive-based pay is particularly relevant for executive workers, our findings on improvement in overall labor welfare post CDS inception suggests firms' efforts in better treating and motivating both executive and non-executive employees. Furthermore, broad-based profit sharing schemes help CDS firms to minimize voluntary turnover by partly reducing workers' concerns on employers' stability.

In Chapter 3, we theoretically examine whether creditors' access to the CDS market changes their incentive to use traditional tools of financial contracting, such as debt covenants, for protection of their interests. Our study is mainly motivated by recent empirical findings of Shan, Tang, and Winton (2019), who focus on the effect of the CDS market on design of corporate debt contracts with particular reference to loan contractual protection. The authors document less restrictive covenants and lower collateral requirements in newly issued loans of CDS-traded firms. Based on these findings, they suggest that the access of creditors to the CDS market improves contracting efficiency by substituting loan contractual protection and reducing contracting costs. They argue that these results can be explained by lenders' moral hazard in the presence of CDSs, which reduces lenders' incentive to monitor. However, this argument remains weak.[3] To the best of our knowledge, we provide the first theoretical study that analyses the effect of CDS introduction on debt covenants and establishes the predictions for empirical analysis to test.

In theory, we can say that one instrument can change the incentive to use another instrument when it either can replace it as an adequate substitute, or when it

[3] The argument that the introduction of CDSs weakens creditors' incentive to monitor remains controversial. Creditor monitoring of borrowers goes beyond monitoring of loan terms, and it also represents an important task for bank regulatory compliance. Banks are required to maintain adequate provisions, reserves and capital levels. Timely monitoring of borrower financial condition underlies the assessment of an appropriate amount of loan loss reserves, which in turn affects lenders' Tier 1 regulatory capital (Guidance on credit risk and accounting for expected credit losses, BIS, 2015). The requirement to comply with supervisory standards (e.g., comprehensive credit risk management, maintenance of adequate capital levels) remains unchanged for CDS-protected lenders.

can affect the work of another tool in the joint use. The substitution of one instrument for another is possible just when it is made to function like the original. In other words, we can expect that CDS trading can replace covenants in loan agreements, if it solves problems that are typically addressed by covenants.

Traditionally, debt holders include covenants in loan agreements as a way to reduce the costs of no-commitment by disciplining and determining the set of policies that shareholders are committing to. Contract incompleteness and lack of commitment of equity holders to repay a debt and/or implement policies that maximize firm value create agency conflicts between debt and equity. Examples of these conflicts are strategic default, dilution of the value of existing debt claims, asset substitution, underinvestment and leverage ratchet effect in the form of resistance to debt reductions.

The rise of the CDS market has created a new commitment device for borrowers to repay their obligations. Redistribution of the bargaining power in favour of creditors following the introduction of CDSs reduces the incidence of strategic default by making debt renegotiation more difficult (e.g., see Bolton and Oehmke, 2011; Danis and Gamba, 2018; Kim, 2016). Despite the ability of CDSs to reduce strategic default incentive, it is not clear a priori how CDSs affect agency distortions in borrowers' investment and financing decisions caused by lack of commitment. Intuitively, with CDSs, self-interested equity holders should reflect in their decisions the lower possibility of future renegotiation in financial distress. On the one hand, the increased renegotiation frictions and the subsequent reduction of the occurrence of strategic default might reduce deviations from firm value maximising decisions.[4] On the other hand, the anticipation of forceful liquidation with no chance to renegotiate the debt might increase the equity holders' incentive to engage in opportunistic behaviours, especially when the firm approaches financial distress.

Taking into account that both CDSs and covenants can improve contracting efficiency by increasing ex post shareholders' commitment, we theoretically examine if the presence of one instrument changes the incentives to hold the other. We construct a two-period model with a levered firm that optimally chooses investment in each period and decides whether to repay the debt or renegotiate it with the creditors at the end of the period. The model captures important features of real world contracts such

[4]For instance, Pawlina (2010), drawing on the results of his theoretical model, suggests that the debt overhang might be reduced by higher renegotiation frictions such as in public debt, for which disperse debt holding increases coordination costs and makes renegotiation prohibitively expensive (Rajan, 1992), and/or in legal systems with strong enforcement of creditors' rights (Favara, Schroth, and Valta, 2012).

as contract incompleteness and lack of commitment of equity holders. The latter leads to a possibility of strategic default, whereby even in a solvent state the shareholders threaten to default strategically and renegotiate to appropriate creditors' wealth. The presence of risky debt and the lack of commitment to repay it naturally create an incentive to underinvest given the anticipation that some benefits from investing in capital might be transferred to the creditors under renegotiation. Overall, the model generates both underinvestment and strategic default.

Using this baseline model, we examine the rationality for creditors to have either instrument or both. Specifically, we first measure how effective covenants and CDSs considered individually in protecting the debt from agency conflicts by reducing deviations from firm value maximizing investment decisions and shareholders' incentive to default strategically. Next, by allowing the two instruments together, we examine any changes in effectiveness of each instrument under the presence of the other. We find that the access of debt holders to credit insurance can indeed reduce their incentive to include covenants in loan agreements. But the reason of this reduced incentive lies not in the substitutive effect of the CDS market discussed broadly in empirical literature, rather in its detrimental effect on covenant effectiveness.

Specifically, our model demonstrates debt covenants as a more universal tool for debt protection, which cannot be replaced by CDS trading. While both CDSs and covenants increase debt protection by reducing the likelihood of strategic default, the instruments are not equally effective in reducing distortions of the optimal investment policy caused by lack of commitment. Unlike covenants, the effect of CDSs on underinvestment is ambiguous (i.e., it can both alleviate or exacerbate the debt overhang problem) and conditional on the likelihood of the empty creditor threat. In these situations, credit derivatives and covenants are not substitutes.

Interestingly, we also show a new effect of CDS trading on covenants, which has been overlooked in the literature. We find that the effectiveness of covenants in alleviating underinvestment post CDS inception is mainly determined by the probability that creditors force a liquidation. When there is a high risk for borrowers being affected by empty creditors, covenants lose their effectiveness in solving the debt overhang problem.[5] These findings are not inconsistent with Shan, Tang, and

[5] Anecdotal evidence on the empty creditor behavior exists beyond numerous cases in the period of the Great Financial Crisis. As an example before the crisis, in 2003-2005, underlying companies, such as an American energy company Mirant and a global designer and producer of vehicle structural components Tower Automotive, were unable to work out a deal with CDS-protected lenders and were forced to file for Chapter 11. More recently, CDS protection buyers speculated on the failure of Caesars Ent. (in 2014), Windstream (in 2019), and Thomas Cook (in 2019). See Danis and Gamba

Winton (2019) or with other empirical papers on covenants and CDSs, but they provide a new explanation for why covenants have become looser following CDS trading. Covenants are costly because they constrain a firm's behavior. If they are not useful in addressing the debt overhang problem after the introduction of CDSs, then it makes sense for the firm and the lender to negotiate looser covenants at loan inception.

Chapter 4 takes a step further and tests empirically the theoretical predictions developed in Chapter 3. Differently from the study of Shan, Tang, and Winton (2019), we propose a direct test on the ability of CDS contracts being used as an adequate substitute for debt covenants by focusing on potential distinctive characteristics of the two commitment mechanisms. We rely on the existing literature of empirical investment models considering debt overhang problem, and test individual and joint effects of CDSs and financial covenants on the investment distortions caused by debt overhang.

Based on the sample of U.S. private loans, we find strong empirical support for the comparative statics predictions developed in Chapter 3. We find that the investment-distortion effect of CDSs dominates. In other words, the negative investment effect of debt overhang is amplified after the introduction of CDS trading on firm debt. Furthermore, the investment-distortion effect of CDSs is more prominent for firms with the higher likelihood of the empty creditor threat, such as for the higher amount of CDS insurance written on firms and/or the weaker firms' fundamentals. In contrast, stricter financial covenants restore investment incentive destructed by debt overhang. However, in the post - CDS inception, covenants lose their effectiveness as a mechanism against no-commitment. The CDS market undermines shareholders' incentive to undertake valuable investment despite the presence of strict covenants in a loan contract.

In our empirical analysis, we address potential endogeneity concerns with respect to both the timing of CDS introduction and the financial covenant strictness, using the implementation of the CDS Big Bang Protocol on April 4, 2009 as a quasi-natural experiment and an instrumental variable approach, respectively. In addition, we perform various checks and confirm that our findings are robust to alternative measures of the likelihood of the empty creditor threat and underinvestment.

In summary, the thesis contributes to the ongoing debates on the welfare effects of the CDS market by revealing previously undetected its positive and negative effects. On the one hand, we find the positive effect of CDSs on human capital, the firm's

(2019) for the summary of recent involvement of CDS buyers/sellers in bankruptcy/restructuring.

asset not listed in the balance sheet but bringing essential economic value for the firm's business and the economy as a whole. On the other hand, we demonstrate the detrimental effect of CDSs on effectiveness of traditional tools of financial contracting, such as debt covenants, used by creditors to reduce debt-equity agency conflicts. Notwithstanding the potential loss of covenant effectiveness following the introduction of CDS trading, debt holders should be particularly careful in loosening strictness of covenants in credit contracts given its complementary value in reducing the incidence of strategic debt service and the likelihood of inefficient liquidation caused by CDS-protected empty creditors.

Chapter 2

Credit Default Swaps and Human Capital

2.1. Introduction

Credit default swaps (CDSs) are credit derivatives providing an effective tool for credit risk transfer. Recent literature documents the real effects of CDSs on reference firms' bankruptcy risk, financial polices, firm value, and even spillover effects to their suppliers. However, there is ongoing debate on the welfare effects of CDSs. Human capital is increasingly seen as one of the most crucial asset for corporate competitive success (Zingales, 2000). As an important stakeholder of the firm, employees can suffer significant losses when their employer firms are in distress or file for bankruptcy. Corporate debt and investment policies can affect employee wealth directly though its effect on performance-based compensation and indirectly through adjusting base pay for changes in overall firm risk. Does the introduction of CDS trading on a firm's debt affect its employee wealth and overall labor welfare? In this study, we empirically investigate the effect of CDS contracts on one of reference firms' key stakeholders – employees.

CDSs can affect employee wealth through various channels. First, through the inability of employees to fully insure their human capital risk. Corporate financial distress and bankruptcy can impose significant costs for firms' employees. To avoid an immediate bankruptcy, highly levered distressed firms could have a strong incentive to cut costs associated with employee pay and benefits to ensure full repayment of debt. Further, if firms are forced into bankruptcy, employees could be fired. That generates potential future earning losses for employees associated with long delay before re-employment and costly job search (Diamond, 1982; Katz and Meyer, 1990; Lazear, 2009). Consistent with the stakeholder theory, in competitive labor market, firms with a greater distress risk have to provide higher ex ante wages to compensate employees' concerns on human capital risk (e.g., Berk, Stanton, and Zechner, 2010; Jaggia and Thakor, 1994; Titman, 1984). These compensating wage differentials represent indirect costs of financial distress paid by firms ex ante.

The introduction of CDS trading on a borrower debt makes hedged creditors tougher in debt renegotiation through increasing their incentives to impose harsher loan terms over the process of renegotiation, or, in a case of creditors' over-insurance, to push the reference firm into bankruptcy to trigger the payment from their CDS positions. At the same time, the ability to hedge with CDSs also encourages creditors to lend more to reference firms ex ante (Bolton and Oehmke, 2011). Empirical evidence confirms firms' increased leverage, bankruptcy risk and less out-of-court debt restructuring after the introduction of CDS trading on their debt (Danis, 2016; Saretto and Tookes, 2013; Subrahmanyam, Tang, and Wang, 2014), that in turn might raise employees' concerns on their human capital risk and result in the ex ante increase in employee pay post CDS introduction. Since risk-averse employees would naturally prefer a dollar increase in base salary to a dollar increase in "target" bonus or any other variable compensation (Murphy, 1999), we expect that the increase in employee pay due to unemployment concerns is concentrated mainly in the base salaries. Taken together, we label this as the "human capital risk" channel.

Furthermore, CDSs can affect the employee compensation through the interest alignment between employees and shareholders based on principle-agent concerns. Back to the seminal work of Jensen and Meckling (1976), the literature argues that to implement second-best corporate policies shareholders adjust managerial compensation structure in a way to induce managers to take actions that increase equity value. Given that these actions might be beneficial for shareholders at the expense of creditors, creditors price debt issues accordingly (e.g., see Brockman, Martin, and Unlu, 2010).

The introduction of CDS trading increases credit supply for CDS firms that can be used to finance more investments projects (Bolton and Oehmke, 2011). The reduced monitoring incentive and increased risk tolerance from CDS-protected creditors also give firms greater flexibility in choosing investments (Morrison, 2005; Parlour and Winton, 2013). Therefore, to take advantage of the relaxed financing constraints and increased lenders' risk tolerance post inception of CDS trading, shareholders of

CDS firms have an incentive to further align managers' interests and encourage their risk taking to maximize equity value. Specifically, we expect the growth in convex CEO packages through the increase in equity-based pay and vega incentives. While the incentive-based pay is particularly relevant for executive workers, CDS firms may also want to increase efforts and productivity of general workers, for instance, through providing employees additional non-contractual benefits (Edmans, 2011). We label this as the "interest alignment" channel.

It is worth noting that human capital and interest alignment channels are not mutually exclusive and can coexist with each other. As an example, the relaxation of credit constraints and the increased debt capacity post CDS introduction, on the one hand, lead to higher ex ante wages consistent with greater employees' concerns on human capital risk.[1] On the other hand, it requires an adjustment of managerial pay structure to induce managers to implement more aggressive debt policy. Risk-averse and undiversified managers might be reluctant to support the increase in leverage post CDS inception, that eventually might hurt their personal interests. Even under condition of reduced lender monitoring, interests of risk-averse managers would be largely aligned with those of lenders. Consequently, to align managers' interests with those of shareholders, we expect an increase in convexity in executive compensation that allows to encourage risk-taking by giving managers opportunity to share in the gains but not all of the losses (e.g., see Jensen and Meckling, 1976).

To empirically investigate the effect of CDSs, we first identify a sample of 953 firms with CDS trading introduced on their debt at some point between 1997 and 2013. We match CDS data against data of employee compensation for both executive workers (presented by payments to CEOs) and regular workers (presented by average employee pay). Our baseline results show that the introduction of CDS trading on firm's debt leads to an increase in employee compensation for both executive and non-executive workers. The positive effect of CDS trade initiation is both statistically and economically significant. On average, the introduction of CDSs corresponds to a 8% increase in average employee pay and a 10% increase in total CEO compensation. Interestingly, opposite to regular workers, the compensation of whom is mostly presented by the fixed (base) pay, we find insignificant changes in CEOs' salaries after CDS contracts start trading on the debt of the average firm. The growth in

[1]Firms with high leverage pay higher ex ante wages to mitigate workers' concerns on unemployment risk in bankruptcy (e.g., see Berk, Stanton, and Zechner, 2010; Chemmanur, Cheng, and Zhang, 2013). The positive interaction between financial leverage and firm's probability of entering distress are supported by number of studies (e.g. see Ofek, 1993). Ofek (1993) shows that higher pre-distress leverage increases the probability of employee layoffs and reductions in wages and benefits in order to meet outstanding debt obligations.

total CEO compensation instead is mainly driven by the increase in equity-based (long-term incentive) compensation.

We use multiple methods to address the potential selection bias and endogeneity concerns on CDS trading. One potential concern is that CDS traded firms (henceforth, CDS firms) might be different from non-CDS firms in ways that are systematically related to firms' employee-related decisions. In addition to the fixed effects controls in all model specifications, we apply a propensity score matching procedure to conduct a matched-sample analysis with CDS firms (as a treatment group) and non-CDS firms (as a control group). To mitigate a potential bidirectional causal relation between CDS trade initiation and employee pay policy, we conduct a direst test on reverse causality by applying the method suggested in Bertrand and Mullainathan (2003). Finally, to further mitigate the endogeneity concerns, we use the instrumental variable (IV) approach with the lenders' foreign exchange hedging activities as an instrument. Lenders with larger foreign exchange hedging positions are more likely to hedge the credit risk using CDSs (Minton, Stulz, and Williamson, 2009). Altogether, our endogeneity tests support a positive and causal relation between the initiation of CDS trading and employee pay policy.

Having established the relationship between CDSs and employee pay, we further investigate the channels that may drive these results. Consistent with the "human capital risk" channel, we find the stronger CDS effect on wages (base pay) for firms whose workers face greater expected exposure to unemployment risk. Specifically, employees demand higher wages following the introduction of CDSs in industries with greater layoff propensity and longer delay in workers' re-employment. In addition, we find the more pronounced increase in employee pay in less generous US states that provide low unemployment insurance benefits (i.e., with higher costs to workers during unemployment). Furthermore, the positive effect of CDS trading on wages increases with employee bargaining power as measured by cross-industry heterogeneity in labor union coverage. Where highly unionized industries are characterized by a higher ability to bargain with management for higher wages.

Note that employees' demand of higher promised wages in response to increased bankruptcy risk does not require that workers are able to directly assess firms' credit risk, observe CDS trading, or track CDS spreads. Brown and Matsa (2016) find that job seekers accurately perceive firms' financial condition. The signals regarding employment stability can be obtained from a variety of sources, such as media report, credit rating agencies, and even word of mouth. In addition, CDSs can further improve this information environment (Acharya and Johnson, 2007; Kim, Shroff, Vyas, and Wittenberg-Moerman, 2018).

Next, we test the "interest alignment" channel. The separation of ownership creates concerns on principle-agent issue. To align interests, equity-based contracts can be used to directly link managers' payoffs to a shareholder value (Jensen and Meckling, 1976). That is exactly what we can observe in our results for executive workers, the growth in total compensation of whom post CDS inception is mainly driven by the increase in equity-based pay. In addition, we test how managerial incentives in CEOs' compensation packages, such as the sensitivity of CEO wealth to stock price (delta) and the sensitivity of CEO wealth to stock return volatility (vega), alter in response to the introduction of CDS trading. While the increased delta in the compensation structure creates effort incentives, the risk-averse and under-diversified managers may still forgo some positive NPV projects if they are risky. This can be mitigated by increasing vega incentives, associated with convex payoffs in the form of option grants and holdings. Controlling for the endogenous feedback effects of corporate policy choices and managerial incentives in simultaneous systems of equations (3SLS), we find the increase in the sensitivity of CEO wealth to stock return volatility (vega) post CDS inception, that reduces managers' aversion to take "riskier" policy choices (e.g., in the form of higher firm leverage and more investments in innovation).[2]

Finally, using Environmental, Social and Corporate Governance (ESG) STATS data on employee relationship ratings, we find that the effect of CDSs on general employees is associated not just with higher base wages, but also in the form of improvement in overall labor welfare, particularly in broad-based cash profit sharing and health and safety benefits. These results suggest CDS firms' efforts in better treating and motivating both executive and non-executive employees. Furthermore, broad-based profit sharing schemes minimize voluntary turnover in firms by partly reducing workers' concerns on employers' stability.

Our study sheds new light on the real effects of credit derivatives. We provide the first comprehensive assessment of the effect of CDSs on human capital representing one of the key non-financial stakeholders of firms. We find that the inception of CDS trading on borrowers' debt leads to the increase in employee pay and the improvement of labor welfare measures. These findings add positively to the ongoing debates on the welfare effects of CDSs. Our study also helps to improve our understanding of the determinants of corporate labor relationship and emphasizes the role of credit

[2]We follow Coles, Daniel, and Naveen (2006) and use a term "risky" policy choices based on its translation into greater firm risk represented by higher stock return volatility.

derivatives in shaping corporate human capital related policies.

The remaining of the chapter is organized as follows. Section 2.2 discusses the relevant literature. Section 2.3 describes data and samples used in the empirical analysis. Section 2.4 presents baseline empirical results and addresses potential selection bias and endogeneity concerns. Section 2.5 establishes channels through which CDSs affect the employee pay policy and documents the CDS impact on corporate labor welfare. Section 2.6 concludes the chapter.

2.2. Related Literature

Our study relates to the literature on the real effects of CDSs, stakeholder theory of capital structure, and managerial compensation and incentives.

2.2.1. Real effects of CDS

The availability to hedge credit risk with CDSs can affect the real side of borrowing firms by altering the debtor-creditor relationship. Bolton and Oehmke (2011) first theoretically show that the introduction of CDS trading have both positive and negative effects on CDS-referenced borrowing firms. On the one hand, the introduction of CDS reduces the incidence of strategic default due to strengthening bargaining power of creditors in debt renegotiation. That allows borrowing firms to increase their debt capacities and finance more positive net present value projects ex ante. On the other hand, when borrowers face financial distress, CDSs can give rise to inefficient liquidations ex post by producing "empty creditors" who tend to be over-protected with CDSs and have incentives to push the firm into bankruptcy to trigger the payment from their CDS positions even though renegotiation would be efficient.[3] Danis and Gamba (2018) further show that while there are both negative and positive effects of CDSs on firm value, the net effect is positive. After calibrating their theoretical model, they find that firm value increases by 2.9% on average after the introduction of CDS trading on firms' debt. Consistent with the previous literature, they also demonstrate that the CDS market leads to more liquidations, reduces the probability of costly debt renegotiation, increases firm leverage and allows firms to invest more. Morrison (2005) and Parlour and Winton (2013) show that the existence of the CDS

[3]The problem of empty creditors was firstly introduced by Hu and Black (2008) based on the idea of separation of creditors' cash flow rights from their control rights.

market can lead to disintermediation and reduce banks' incentives to monitor their borrowers.

Recent empirical studies generally support the above theoretical predictions. Subrahmanyam, Tang, and Wang (2014) document that the introduction of CDSs leads to the growth in the probability of bankruptcy filing, while Danis (2016) finds that bondholders holding CDSs are less likely to engage in an out-of-court debt restructuring. Kim (2016) demonstrates that CDS trading leads to reduction in stategic default -related cost of corporate debt. Saretto and Tookes (2013) support the greater credit supply for CDS firms, allowing firms to borrow at longer maturity and maintain higher leverage ratios. However, CDS firms save part of their increased leverage as cash holdings (Subrahmanyam, Tang, and Wang, 2017). Corporate innovation outputs are also increased since CDS-protected creditors are more tolerant to corporate risk takings (Chang, Chen, Wang, Zhang, and Zhang, 2019). Chakraborty, Chava, and Ganduri (2015) and Shan, Tang, and Winton (2019) motivate their findings of the effect of CDS trading on debt covenants based on the reduced lenders' incentive to monitor CDS firms. Different from the theoretical prediction of increase in firm value, Narayanan and Uzmanoglu (2018) find net decrease in firm value because of the increased cost of capital.[4]

In addition to the effect of the CDS market on the debtor-creditor relationship, recent literature explores the externality of CDS contracts to related parties. Li and Tang (2016) find that suppliers tend to use less leverage because of the increased bankruptcy risk of CDS-referenced key customers. On the contrary, these suppliers start using more equity financing with lower issuance costs following the improvement of information environment after the onset of CDS trading on their key customers' debts. Li and Tang (2018) further find that CDS-referenced firms gain more market share from their non-CDS industry rivals through more aggressive pricing strategies.[5] Chen, Leung, Song, and Avino (2019) and Hong and Wang (2018) find that CDSs increase CEO risk-taking incentives (vega) in CEOs' compensation.

[4]Theoretically, CDSs can increase or decrease firm value. On the one hand, CDSs can increase firm value because of the decreased incidence of strategic debt service, relaxed credit constrains and reduced costly equity financing, that can be used to finance valuable investment projects. On the other hand, CDSs can decrease firm value due to bankruptcy costs associated with the increased likelihood of inefficient liquidation ex post.

[5]Note that the results of Li and Tang (2016, 2018) are also in line with the predictions of the stakeholder theory of capital structure (e.g., see Banerjee, Dasgupta, and Kim, 2008; Titman, 1984), indicating that in industries producing unique products the price consumers are willing to pay is a decreasing function of the probability of firm's liquidation. While suppliers tend to maintain lower leverage in response to the increased probability of default of their key customers.

Differently from the prior studies, we focus on the effect of CDSs on reference firms' employees, including both general and executive workers. We analyze the effect of CDS trading on human capital through examining changes in employee compensation because of "human capital risk" concerns and "interest alignments". We also explicitly investigate the effect of CDSs on total labor welfare.

2.2.2. Human capital costs and compensation incentives

Workers are an important stake holder of a firm. Concerns on ex post human capital risk, associated with significant costs imposed on employees by corporate financial distress and bankruptcy, increase indirect bankruptcy costs for firms through higher ex ante wages. These costs might come from long delay before re-employment (Katz and Meyer, 1990), costly job search (Diamond, 1982) or a limited supply of match-specific job opportunities (Lazear, 2009). The stakeholder theory of capital structure emphasizes that these human capital related indirect bankruptcy costs can be large enough to prevent corporate use of additional debt. Optimal capital structure therefore depends on the trade-off between the tax benefits of debt and these ex ante human compensating costs in addition to the ex post costs of financial distress (e.g., Titman, 1984; Jaggia and Thakor, 1994; Berk, Stanton, and Zechner, 2010).[6]

Recent empirical papers specifically quantify the employee costs of corporate bankruptcy and the corresponding effects on ex ante wage premium. Based on individual-level micro data from Census, Graham, Kim, Li, and Qiu (2019) find that employee annual earnings decrease by 10% following employer's bankruptcy and stay below a pre-bankruptcy level for at least six years. The affected employees are more likely to leave the firm, industry, and local labor market. Eckbo, Thorburn, and Wang (2016) find that just one-third of the incumbent CEOs in bankrupt firms maintain the executive employment with median zero change in compensation, whereas the remaining two-thirds leave the executive labor market and suffer compensation losses. As a result, firms with high leverage need to pay higher ex ante wages to mitigate workers' concerns on unemployment risk in bankruptcy. These human capital

[6] Traditional trade-off theory of capital structure suggests that the optimal capital structure is the trade-off between the corporate tax saving benefits of debt and bankruptcy costs. However, the observed direct bankruptcy costs (i.e., direct expenses associated with the bankruptcy process) is too low to be a sufficient disincentive for firms to take higher levels of debt and inconsistent with the observed leverage (e.g., Andrade and Kaplan, 1998; Graham, 2000). A growing body of literature suggests indirect bankruptcy costs as a solution to this puzzle. It shows that the event of liquidation can impose significant costs for the firm's stakeholders (customers, workers, and suppliers), that can also significantly affect the firm's capital structure.

costs increase corporate indirect bankruptcy costs and limit the use of debt (Agrawal and Matsa, 2013; Chemmanur, Cheng, and Zhang, 2013; Graham, Kim, Li, and Qiu, 2019).[7] However, the presence of exogenous factors reducing the human capital loss in bankruptcy, such as greater unemployment benefits (Agrawal and Matsa, 2013) or larger labor market (Kim, 2018), is positively associated with the debt usage. Shocks to employees' bargaining positions also affect the unemployment risk related ex ante wage premiums (Singh and Naaraayana, 2018).

Even when there are no liquidation costs for employees, firms have a desire to keep and maintain their reputation for treating employees fairly given the value human capital can create. While poor employee welfare, such as high injury rates in workplace, can decrease firm value because of labour productivity losses, legal-related expenses, regulatory fines or reputational costs, etc. (e.g., see Cohen and Wardlaw, 2016). Firms with a high level of employee satisfaction generate superior long-horizon returns through improved recruitment, retention and better motivation of current workers (e.g., see Edmans, 2011). Chang, Fu, Low, and Zhang (2015) and Liu, Mao, and Tian (2017) document an unique importance of human capital in enhancing corporate innovation performance.

To maximize equity value, shareholders can also adjust employee compensation structure to align employees' interest based on principle-agent concerns. That is particularly important for executive compensation given managers' involvement in firm value critical decisions. The alignment of interests can be achieved through regulation of both the convexity and slope of the relation between firm performance and employee wealth. While the higher slope (delta) motivates employees to work harder due to sharing gains and losses with shareholders. The increase in the convexity (vega) in compensation allows to encourage risk-taking by giving employees an opportunity to share in the gains but not all of the losses (e.g., see Jensen and Meckling, 1976). Coles, Daniel, and Naveen (2006) document that riskier corporate policies, such as higher R&D, lower capital expenditures, higher leverage, cause a higher vega in CEO pay, whereas less risky policy choices cause a higher delta.

Taken together, the prior studies indicate the effect of human capital risk and principle-agent concerns on employee compensation and corresponding incentives. We contribute to this literature by documenting the role of credit derivatives in affecting

[7]Agrawal and Matsa (2013) estimate that the size of ex-ante indirect bankruptcy costs given unemployment risk is about 60 basis points of firm value for a typical BBB-rated firm. They show that these costs can explain nearly 90% of the difference between the tax benefits of debt and the risk-adjusted ex post costs of financial distress calculated in previous studies.

employee pay and total labor welfare.

2.3. Data and Summary Statistics

Corporate CDS contracts are traded over the counter. We identify our sample of CDS firms by combining three data sources: CreditTrade (from June 1997 to March 2006), the GFI Group (from 2002) and Markit (from 2002). We use the first trading date for each firm's CDS contract in our sample as their CDS introduction date. The overlapping in samples of the data sources allows us to cross-check and ensure the accuracy of our identifications of CDS firms and their CDS introduction date. In the combined sample, we have 953 North American firms that have CDS trading initiated on their debt at some time during 1997 and 2013.[8] Panel A of Table 2.1 reports the distribution of CDS trade initiation by year. The largest number of CDS contracts was initiated during the 2000-2003 period. Panel B shows the distribution of CDS firms by industry based on the Standard Industrial Classification (SIC) codes. Our sample of CDS firms is quite diversified across industries with most of firms operating in manufacturing (35%), finance and insurance (13%), and electric and gas (10%) industries.[9]

CDS data are merged with employee compensation data by matching company names and CDS trading inception dates to company names and corresponding active dates in employee pay data sources. To make sure that our samples of employee compensation cover the same time period as CDS data, we consider a period starting from 1996, one year before the earliest available date of CDS trading, to 2013. We use annual data given that employee pay data are not reported at the quarterly frequency. All continuous variables in our analysis are winsorized at the 5% at both tails of their distributions. All dollar amounts are adjusted for inflation using the annual average CPI index for urban consumers as of 1996 from the Bureau of Labor Statistics.

Following Chemmanur, Cheng, and Zhang (2013) and Akyol and Verwijmeren (2013), we measure the average employee pay as the ratio of total labor expenses to the number of employees based on Compustat Industrial Annual database. We exclude

[8]The starting point of our CDS sample is 1997, which is generally recognized as the origin year of the broad CDS market. See Subrahmanyam, Tang, and Wang (2014) for details of the sample construction.

[9]We do not exclude financial and utilities companies throughout our empirical analysis owing to the low reporting rate of total labor costs in Compustat. However, keeping financial and utilities companies in the sample does not affect our results.

Table 2.1: **Distribution of CDS firms.** This table reports the distribution of firms with CDS trading initiated on their debt between 1996 and 2013. Panel A reports the distribution of CDS trading initiation presented by number of new CDS firms per year for the sample of all U.S. companies included in the Compustat database, for the sample of Compustat firms having valid information on total labor expenses and for the sample of Compustat firms having information on CEO pay from the ExecuComp database. Panel B reports the distribution of CDS firms across industries based on the SIC code for the sample of all U.S. companies included in the Compustat database.

Panel A: Distribution of CDS trade initiation by year

	All sample		Non-executive sample		CEO sample	
Year	Total # firms	New CDS firms	Total # firms	New CDS firms	Total # firms	New CDS firms
1997	12440	36	726	13	1366	29
1998	12557	64	701	15	1438	53
1999	12533	55	659	10	1480	49
2000	12097	105	657	21	1488	90
2001	11585	161	664	35	1450	137
2002	11253	208	644	31	1460	169
2003	11065	100	648	6	1522	77
2004	10898	69	644	12	1510	45
2005	10853	63	628	11	1506	34
2006	10886	25	619	4	1577	20
2007	11044	11	617	1	1950	7
2008	10866	9	600	3	1889	5
2009	10840	28	606	6	1826	5
2010	11078	11	618	3	1822	2
2011	11687	4	861	0	1788	4
2012	11860	2	901	0	1750	2
2013	11782	2	940	0	1718	1
Total		953		171		729

Panel B: Distribution of CDS firms by industry

Industry	CDS firms	%
Agriculture, Forestry and Fishing	3	0.3
Mining	59	6.2
Construction	16	1.7
Manufacturing	334	35.0
Transportation	36	3.8
Communications	73	7.7
Electric, Gas and Sanitary service	99	10.4
Wholesale Trade	18	1.9
Retail Trade	52	5.5
Finance, Insurance	121	12.7
Real Estate	54	5.7
Services	88	9.2
Total	953	100.0 %

companies with less than one hundred employees. We consider the average employee pay as a general proxy for base (performance-insensitive) compensation given the high percentage of base pay (i.e. wages and salaries) in regular employee compensation structure.[10] Total labor expenses is a supplementary income statement item with about 20% of firms recorded in Compustat having valid information. To address a potential sample-selection bias created by missing information on total labor expenses (i.e. if firms are selective in their decision to report this information), we adopt a Heckman (1979) two-step analysis. In total, there are 12,143 firm-year observations that have non-missing values for the variables to be included in the baseline regression of non-executive employee pay. There are 171 distinct CDS-referenced firms representing 13% of observations in the final sample of non-executive pay analysis.

Data on executive compensation are retrieved from the Standard & Poor's (S&P) ExecuComp database, which provides detailed information on compensation and individual characteristics of the top five executives of more than 3,330 firms from 1992 onward. We measure CEO compensation as CEO total pay and further decompose the total measure into salary, cash bonus, and equity-based pay. We include the main individual CEO characteristics, such as age, tenure, chairman position and sex, as controls in our analysis of CEO compensation. In addition, we investigate the corresponding managerial incentives created by the structure of compensation, including delta and vega. The calculation of these variables is based on the Black and Scholes (1973) option valuation model accounting for dividends (Merton, 1973), which uses information from a variety of data sources, such as ExecuComp, CRSP, Compustat and FRED Economic data. Our executive pay sample includes 729 firms with CDS trading over 1997-2013. In total, there are 28,847 firm-year observations, with 32% of observations represented by CDS firms.

Additionally to compensation variables, we construct a firm level measure of overall labor welfare determining employee-friendly practices in firms based on data of Environmental, Social, and Corporate Governance (ESG) performance. We use five components of employee relations in the calculation of labor welfare: union relation strength, cash profit sharing, employee involvement, retirement benefits strength, and health and safety strength. Section 2.5.4 provides detailed description of the database and the employee relations variables.

The summary statistics of variables used in the empirical analysis are provided in Table 2.2. Appendix 2.A1 provide detailed definitions of these variables. We

[10]Total labor costs in Compustat aggregate salaries and wages, pension costs, payroll taxes, incentive compensation, profit sharing, and other benefit plans. We cannot distinguish the performance-insensitive and incentive part of compensation for general employees. In Section 2.5.4, we do have an analysis based on employee relations/welfare ratings which can proxy employees' motivation.

exclude observations with missing values for the variables employed in the regressions. Our sample is comparable to previous studies. On average, CDS traded firms are larger and more productive (measured by average sales per employee and physical capital intensity), have lower market-to-book ratios and higher firm leverage than non-CDS firms. In addition, CDS firms have more employees and higher executive and non-executive employee wages compared to non-CDS firms. The mean average employee pay and CEO total compensation are \$73.54 thousands and \$7.406 million for CDS firms, while these numbers are \$54.99 thousands and \$3.095 million for non-CDS firms. Due to the wide range of employee pay in our sample, we use the natural log of all employee compensation variables in our analysis to reduce the potential impact of outliers. We further find that CEOs in CDS firms have significantly higher mean values of vega and delta than non-CDS firms (\$212.32 thousands vs. \$74.64 thousands and \$705.81 thousands vs. \$363.78 thousands, respectively), indicating stronger risk-taking incentives in managerial compensation. In addition, CDS traded firms have a significantly higher total labor welfare measure (with mean value of 0.52) than non-CDS firms (with mean value of 0.15). CDS firms outperform non-CDS firms in each five components of positive performance indicators of employee relations. However, there is no significant difference in CEO characteristics between CDS and non-CDS firms. The average CEO age is 56 years, ranging from 29 to 96. In the sample, 98% of CEOs are male with the average tenure of 7 years. CDS traded firms differ from non-CDS firms just in the percentage of the CEOs who also serve as the chairman of the board. On average, in CDS traded firms 77% of CEOs have also the chairman position in the board versus 60% of those in non-CDS firms.

In our analysis, to construct our instrumental variable, we use data from Federal Reserve call reports, DealScan syndicated loan database and Mergent Fixed Income Securities Database (FISD). We use annual publications of "Significant Provision of State unemployment insurance (UI) Laws" of US Department of Labor to get data on UI benefit schedules across US states. To get data on mass layoff statistics across industries and total industry employment, we rely on information provided by US Bureau of Labor Statistics (BLS) "Mass Layoff Statistics" and the US Bureau of Economic Analysis (BEA), respectively. To conduct tests on employee bargaining power, we use the percentage coverage of labor unions across industries based on "Union Membership and Coverage Database". Data on stock prices and returns are obtained from the Center for Research in Security Prices (CRSP) database.

Table 2.2: **Summary statistics.** This table reports summary statistics of variables with non-missing observations during 1996-2013. Panel A (B) summarizes variables for CDS firms and non-CDS firms used in the analysis of general employee (CEO) pay. There are 171 firms for the average employee sample and 729 firms for the CEO sample that have CDS trading uninitiated on their debt at some point during 1997-2013. Panel C summarizes the labor welfare variables between 2003 and 2009. The total number of CDS traded firms in the labor welfare subsample is 524. All continuous variables are winsorized at the 5th and 95th percentiles. All dollar amounts are adjusted to 1996 dollars using the consumer price index. See Appendix 2.A1 for variable definitions.

	CDS firms						Non-CDS firms					
	N	Mean	SD	Min	p50	Max	N	Mean	SD	Min	p50	Max
Panel A: Non-executive sample												
Total labor costs (mln)	1595	2.37	1.66	0.00	2.08	4.48	10548	0.73	1.25	0.00	0.15	4.48
Number of employees (th)	1595	29.52	17.11	0.13	33.81	46.50	10548	12.03	15.97	0.13	3.53	46.50
Average employee pay (th)	1595	73.54	35.91	10.01	67.47	150.07	10548	54.99	39.49	10.01	46.52	150.07
Sales/employee (mln)	1595	0.36	0.28	0.04	0.28	1.19	10548	0.31	0.30	0.04	0.21	1.19
Firm size	1595	8.74	1.54	1.56	8.91	10.92	10548	6.32	2.49	-0.27	6.30	10.92
Leverage	1595	0.34	0.20	0.00	0.30	1.40	10548	0.27	0.23	0.00	0.23	1.40
MB	1595	1.20	0.77	0.11	0.99	5.46	10548	1.38	1.30	0.11	1.01	11.52
PCI	1595	0.62	0.46	0.00	0.62	1.86	10548	0.60	0.47	0.00	0.53	1.86
Panel B: CEO compensation sample												
Total compensation (mln)	9364	7.41	4.94	0.47	6.19	16.59	19483	3.10	3.20	0.47	2.00	16.59
Salary (mln)	9395	0.91	0.27	0.25	0.94	1.30	19629	0.58	0.24	0.25	0.55	1.30
Bonus (mln)	5264	1.15	0.69	0.00	1.01	2.12	9963	0.53	0.51	0.00	0.36	2.12
Equity-based pay (mln)	8336	4.18	3.55	0.00	3.26	11.00	15237	1.66	2.37	0.00	0.79	11.00
Vega (mln)	5100	0.21	0.18	0.00	0.15	0.55	13072	0.07	0.10	0.00	0.04	0.55
Delta (mln)	5100	0.71	0.75	0.01	0.41	2.58	13072	0.36	0.0.55	0.01	0.15	2.58
Firm size	9364	8.59	1.39	2.81	8.56	11.45	19528	6.54	1.33	2.81	6.55	11.45
Leverage	9364	0.30	0.18	0.00	0.28	0.86	19528	0.20	0.19	0.00	0.15	0.86
MB	9364	1.37	1.05	0.15	1.09	8.15	19528	1.67	1.44	0.15	1.22	8.15
TRS	9364	0.23	1.08	-0.87	0.08	8.82	19528	0.26	1.20	-0.87	0.05	8.82
CEO Male	9364	0.98	0.13	0.00	1.00	1.00	19528	0.97	0.16	0.00	1.00	1.00
CEO Age	9364	56.24	6.56	35.00	56.00	83.00	19528	55.08	7.67	29.00	55.00	96.00
CEO Tenure	9364	6.36	6.61	0.00	4.00	35.00	19528	7.55	7.28	0.00	5.00	35.00
CEO Chairman	9364	0.77	0.42	0.00	1.00	1.00	19528	0.60	0.49	0.00	1.00	1.00

Table 2.2 **- Continued**

	CDS firms						Non-CDS firms					
	N	Mean	SD	Min	p50	Max	N	Mean	SD	Min	p50	Max
Panel C: Labor welfare												
Labor welfare measure	2746	0.52	0.77	0.00	0.00	4.00	9451	0.15	0.41	0.00	0.00	3.00
Union relations	2746	0.05	0.21	0.00	0.00	1.00	9451	0.02	0.12	0.00	0.00	1.00
Cash profit sharing	2746	0.09	0.29	0.00	0.00	1.00	9451	0.03	0.18	0.00	0.00	1.00
Employee involvement	2746	0.10	0.30	0.00	0.00	1.00	9451	0.06	0.23	0.00	0.00	1.00
Retirement benefits	2746	0.11	0.31	0.00	0.00	1.00	9451	0.03	0.18	0.00	0.00	1.00
Health and safety	2746	0.16	0.37	0.00	0.00	1.00	9451	0.01	0.10	0.00	0.00	1.00

2.4. CDS and Employee Pay

In this section, we examine the relationship between CDSs and employee pay. We focus on both the general employee pay and CEO compensation. We then address the endogeneity of CDS introduction using various approaches. We also address the sample selection issue given missing information on total labor costs using a Heckman (1979) two-step analysis.

2.4.1. Baseline results

To investigate the relationship between CDSs and employee pay, we estimate the following regression

$$\begin{aligned} EP_{i,t} = \beta_0 &+ \beta_1\, CDS\,Trading_{i,t} + \beta_2\, CDS\,Firm_i \\ &+ \beta_3\, X_{i,t} + \beta_4\, Industry_i + \beta_4\, Year_t + \epsilon_{i,t}, \end{aligned} \tag{2.1}$$

where employee pay, $EP_{i,t}$, is non-executive employee compensation (average employee pay) or CEO compensation (total, salary, bonus and equity-based pay) of firm i in fiscal year t. Following Ashcraft and Santos (2009) and Saretto and Tookes (2013), we include two CDS variables in the baseline empirical specification. The key variable of interest, $CDS\,Trading_{i,t}$, equals one in and after the first year of CDS trading on a reference firm i and zero otherwise. Therefore, β_1 captures the change in employee pay following CDS trade initiation. To capture unobservable time-invariant fundamental differences between CDS and non-CDS firms, we include $CDS\,Firm_i$ which equals one if the firm has CDS traded on its debt at any point during our sample period. We include year fixed effects ($Year_t$) to account for time-specific variation in employee compensation. Whereas industry fixed effects ($Industry_i$) allow to control high heterogeneity in employee pay across industries.[11] The standard errors

[11]Given that employee pay, while substantially differs across industries, typically changes slowly from year to year within a company, we include industry fixed effects rather than firm fixed effects in the analysis. Specifically, our employee pay variables are highly persistent with first-order autocorrelations of 0.95 for average employee pay and 0.76–0.80 for CEO compensation measures. The high persistency of variables reduces the power of panel data estimators (Chang, Fu, Low, and Zhang, 2015; Li and Prabhala, 2007; Zhou, 2001). Liao, Martocchio, and Joshi (2010) emphasize that while it is not always possible to control for firm fixed-effects in empirical research on employee compensation due to highly persistent variables, including a set of industry dummy variables is an absolute must. To control for unobservable time-invariant fundamental differences between CDS and non-CDS firms, in addition to the industry fixed effects we include the indicator variable $CDS\,Firm$.

are robust to heteroskedasticity and clustered by firm level.

We further control for an array of firm and individual executive characteristics ($X_{i,t}$) that have been identified as important determinants of employee compensation in the previous literature (e.g., Chemmanur, Cheng, and Zhang, 2013; Peters and Wagner, 2014). In particular, we incorporate *Firm Size* which is the natural logarithm of market capitalization of firm i in year t. Employees in larger firms generally have higher wages than employees in smaller firms (e.g., see Murphy, 1999). Since high leverage firms need to pay higher compensation (Berk, Stanton, and Zechner, 2010; Chemmanur, Cheng, and Zhang, 2013; Graham, Kim, Li, and Qiu, 2019), we also include *Leverage* measured as total debt to the market value of assets as a control variable. We employ the market-to-book ratio (*MB*) to account for firm growth opportunities.

In addition, specifically for the non-executive employee sample, we also include two productivity variables: sales per employee (*Sales/employee*) and physical capital intensity (*PCI*). *Sales/employee* measures productivity of the average employee of the firm. *PCI* is the ratio of gross property, plant, and equipment to total assets. Capital intensive firms tend to have higher employee pay and be more productive (Cronqvist, Heyman, Nilsson, Svaleryd, and Vlachos, 2009). Specifically for the CEO sample, following the existing literature showing a positive relation between CEO compensation and firm performance (e.g. Murphy, 1999), we also include total return to shareholders (*TSR*) as a measure of firm performance. We further add a number of controls for CEO individual characteristics including the age of the CEO (*CEO Age*), the gender of the CEO (*CEO Male*), the number of years in CEO position in a firm i (*CEO Tenure*), and a dummy variable indicating whether the CEO is also the chairman of the board (*CEO Chairman*).

The baseline results are presented in Table 2.3. From columns (1) and (2), we find a positive and significant coefficient for *CDS Trading* for both the the average employee pay and CEO total pay. The results provide preliminary evidence that CDSs increase employee compensation for both general workers and executive employees. The coefficients of *CDS Trading* represent the treatment effect over the entire post-CDS introduction period, and imply that following CDS introduction the average employee pay increases by 8% (or by 5.9 thousand dollars), while the total CEO compensation increases by 10% (or by 740.6 thousand dollars).[12] Overall, the increase

[12]Given that $d[ln(y)]/dx = [1/y] \times dy/dx$ and $dy = ydx \times d[ln(y)]/dx$, the effect of the change in the dummy variable $CDS\,Trading$ (dx) from 0 to 1 on the change in employee compensation (dy) is calculated as $73.54 \times 1 \times 0.08 = 5.88$ (and $7406 \times 1 \times 0.10 = 740.6$), where \$73.54 (in thousands)

is not only statistically significant, but also economically large.[13]

Using the detailed CEO compensation structure data, we further examine the effect of CDSs on different components of CEO remuneration. Specifically, we decompose the CEO total compensation into salary, bonus and equity-based compensation. The base (performance-insensitive) component of CEO pay is represented by salaries. The incentive (performance-sensitive) component of CEO pay is represented by bonuses and equity-based pay (as the sum of stock options and restricted stock grants).[14] While both bonus and equity-based pay represent incentive pays, bonus is generally cash-based incentive compensation attached to annual accounting performance, that makes it particularly important for lower-level executives. The equity-based pay can be used to directly link managers payoffs to a shareholder value. The results are presented in columns (3)-(5) of Table 2.3. Opposite to non-executive workers, the compensation of whom is mostly presented by the base pay, we find insignificant changes in CEOs' salaries after CDS contracts start trading. With regard to performance-sensitive compensation, the coefficient estimate for *CDS Trading* of equity-based pay of CEOs is positive and statistically significant at the 1% level. Interestingly, the effect of CDSs concentrates mainly on long-term incentive plans (stocks and options), whereas there is no significant effect on short-term incentive plans (bonuses).

The coefficients of control variable are generally consistent with prior literature. Larger and highly leveraged firms pay their employees more than smaller firms and firms with lower leverage. Growth firms (i.e., with high *MB*) pay their employees less than fundamentally solid value firms. Chairman position is a positive and significant determinant of CEO compensation.

and $7406 (in thousands) are mean value of average employee pay and total CEOs' compensation for the CDS traded sample, respectively.

[13]Despite the high magnitude of the results, the growth in employee pay by this amount is practically realistic. This can be seen on a real example of employee pay policy in one of CDS-referenced firms, such as American Airlines. In the same year with the introduction of CDS trading on the company's debt, in 1997, a labor union, Allied Pilots Association, successfully achieved a 9% wage increase over the next three years and established the Pilots Stock Option Plan. The Stock Option Plan granted labor union members to purchase 11.5 million shares of the company, which were exercisable immediately. See Wall Street Journal, "American Airlines Pilots are Expected by Union Leaders to Ratify New Pact", April 7, 1997.

[14]The CEO incentive pay has grown dramatically in recent years and generally represents the largest component of compensation, more than 80% during 2000-2014 (Edmans, Gabaix, and Jenter, 2017).

Table 2.3: **Effect of CDS trading on employee pay.** This table presents the coefficients and standard errors obtained from the baseline regression for the average (non-executive) employee pay sample and the CEO pay sample during 1996-2013. The coefficient of interest is $CDS\,Trading$ which is a dummy variable that equals one if a firm has a CDS trading on its debt during a year and zero otherwise. $CDS\,Firm$ is an indicator equal to one if there is CDS trading on the firm's debt at any time during the sample period. The definitions of variables are presented in Appendix 2.A1. Industry and year fixed effect are controlled. Industry group is defined by the first two digits of the SIC code. The standard errors presented in parentheses are robust to heteroskedasticity and clustered by firm level. The symbols ***,**, and * denote significance levels of 1%, 5%, and 10%, respectively.

Variables	(1) Average employee pay	(2) CEO Total pay	(3) CEO Salary	(4) CEO Bonus	(5) CEO Equity pay
CDS Trading	0.08***	0.10***	-0.00	0.05	0.21***
	(0.04)	(0.04)	(0.01)	(0.04)	(0.03)
CDS Firm	0.14***	0.03	0.10***	0.22***	-0.07*
	(0.04)	(0.04)	(0.02)	(0.05)	(0.04)
Firm size	0.06***	0.47***	0.17***	0.35***	0.53***
	(0.01)	(0.01)	(0.00)	(0.02)	(0.01)
Leverage	0.16***	0.66***	0.45***	0.59***	0.59***
	(0.05)	(0.05)	(0.03)	(0.09)	(0.06)
MB	-0.01	-0.03***	-0.03***	-0.04***	0.00
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Sales/employee	0.00**				
	(0.00)				
PCI	-0.08**				
	(0.04)				
TRS		0.00	-0.00***	0.00**	0.00
		(0.00)	(0.00)	(0.00)	(0.00)
CEO Male		-0.06	-0.05**	0.06	0.00
		(0.06)	(0.02)	(0.12)	(0.06)
CEO Age		-0.00	0.01***	0.01**	-0.01***
		(0.00)	(0.00)	(0.00)	(0.00)
CEO Tenure		-0.01***	0.00	0.00	-0.00
		(0.00)	(0.00)	(0.00)	(0.00)
CEO Chairman		0.07***	0.05***	0.13***	0.00
		(0.02)	(0.01)	(0.04)	(0.02)
Constant	3.15***	4.17***	4.65***	2.77***	3.41***
	(0.06)	(0.12)	(0.05)	(0.19)	(0.12)
Observations	12,143	28,847	29,024	15,227	23,573
R-squared	0.52	0.42	0.56	0.40	0.50
Year FE	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES
Clustered SE	YES	YES	YES	YES	YES

2.4.2. Endogeneity

The baseline results suggest a strong positive relationship between the introduction of CDS trading and corporate employee pay. However, factors determining the assignment of CDS contracts to firms can also affect corporate employee pay policy. In addition, firms with more generous employee pay policy might have a greater propensity to the initiation of CDS trading on their debt. To address these endogeneity concerns, we employ various approaches as suggested in the previous literature, including propensity score matching, reverse causality test and instrumental variable approach.

Propensity score matching

CDS firms can be different from non-CDS firms in ways that are systematically related to firms' corporate decisions. To mitigate this concern, we employ a propensity score matching approach. Specifically, we first model the firm-level probability of initiating CDS trading in each year by estimating the following logit model in the sample of CDS and non-CDS firms:

$$CDS\,Trading_{i,t} = \beta_0 + \beta_1 X_{i,t-1} + \beta_2 Industry_i + \beta_3 Year_t + \epsilon_{i,t}, \tag{2.2}$$

where $CDS\,Trading$ equals one for the year of CDS introduction, and zero otherwise. For non-CDS-firm, $CDS\,Trading$ is always zero. X is the array of firm characteristics reflecting its credit risk and growth opportunities (e.g., see Martin and Roychowdhury, 2015). To account for firms' credit risk, we incorporate $Credit\,rating$, $Investment\,grade$, $Leverage$ and ROA as explanatory variables. By including $Firm\,size$, MB, *Sales/ employee* and PCI as controls, we also account for the effect of growth opportunities that can affect the demand and supply of CDS trading. We tabulate the results of the logit model in Table 2.A2 (Column 1). It shows that the chosen firm characteristics can predict the CDS trade initiation reasonably well, with a pseudo - R^2 of 46%. The coefficients of explanatory variables are generally consistent with prior literature. Large firms, highly leveraged firms, and those with investment grade ratings are more likely to have CDS trading on their debt.

Using the predicted probability of CDS trading from the logit model, we then estimate the propensity score for each firm in each year, and match each CDS firm

Table 2.4: **CDS trading and employee pay: Propensity score matching.** This table presents the estimation of the effect of CDS on employee pay in a sample of propensity score matched CDS and non-CDS firms. Propensity score matched firms are selected based on propensity scores estimated from the "Model 1" of prediction of the probability of CDS trading presented in Appendix 2.A2. The matching procedure is based on selection of one non-CDS firm with the nearest to each CDS firm's propensity score in the same industry and within of difference of 1%. The propensity scores are compared in the year prior to CDS trade initiation. We employ matching with replacement, when a non-CDS firm can be matched to multiple CDS firms. The definitions of variables are presented in Appendix 2.A1. Industry and year fixed effect are controlled. Industry group is defined by the first two digits of the SIC code. The standard errors presented in parentheses are robust to heteroskedasticity and clustered by firm level. The symbols ***,**, and * denote significance levels of 1%, 5%, and 10%, respectively.

Variables	(1) Average employee pay	(2) CEO Total pay	(3) CEO Salary	(4) CEO Bonus	(5) CEO Equity pay
CDS Trading	0.11**	0.11***	-0.06	0.04	0.13**
	(0.05)	(0.04)	(0.08)	(0.05)	(0.05)
CDS Firm	0.09	0.08	0.02	0.04	0.07
	(0.05)	(0.05)	(0.07)	(0.07)	(0.07)
Firm size	0.00	0.35***	0.13**	0.31***	0.44***
	(0.02)	(0.02)	(0.06)	(0.02)	(0.02)
Leverage	0.16*	0.59***	0.58	0.52***	0.63***
	(0.10)	(0.12)	(0.21)	(0.16)	(0.14)
MB	-0.00	0.01	-0.04***	-0.04***	0.05***
	(0.03)	(0.01)	(0.01)	(0.02)	(0.02)
Sales/employee	0.00***				
	(0.00)				
PCI	0.06				
	(0.10)				
TRS		0.00**	0.00	0.00	0.00***
		(0.00)	(0.00)	(0.00)	(0.00)
Constant	3.45***	4.90***	5.20***	3.03***	3.65***
	(0.21)	(0.25)	(0.57)	(0.35)	(0.28)
Observations	2,072	9,471	8,619	5,161	8,296
R-squared	0.73	0.43	0.42	0.35	0.44
CEO characteristics	NO	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES
Clustered SE	YES	YES	YES	YES	YES

in the year prior to CDS trade initiation to one non-CDS firm in the same industry with the closest propensity score but within the difference of 1%. When a non-CDS firm can be matched to multiple CDS firms, we employ matching with replacement.

Roberts and Whited (2012) point out that using a single (i.e., the best) match with replacement and a tighter caliper leads to the least biased and most credible estimates, although some subjects could not be matched.

Table 2.4 reports the employee pay regression results in the propensity score matched sample. The coefficient estimates for $CDS\,Trading$ remain significantly positive at the 1% and 5% for CEO total compensation and average employee pay, respectively. Therefore, the employee pay (both non-executive and executive) increases after the onset of CDS trading, even after adjusting for the propensity for CDS trading. Consistent with the baseline analysis, the growth in total compensation of CEOs is determined by the increase in equity-based pay. It is worth noting that $CDS\,Firm$ variable is not significant in any model specification in Table 2.4, which shows the effectiveness of our matching procedure.

Test on reverse causality

To mitigate a potential bidirectional causal relation between CDS trade initiation and employee pay policy, we conduct a direst test on reverse causality by applying the method suggested in Bertrand and Mullainathan (2003). Specifically, we consider changes in employee pay policy in years around the CDS trade initiation. We replace *CDS Trading* variable in the baseline regression Eq. (2.1) by four indicator variables $Year^{-1}$, $Year^{0}$, $Year^{+1}$ and $Year^{>=+2}$. $Year^{-t}$ ($Year^{+t}$) equals one if CDS trading will be initiated in t years (was initiated t years ago) and zero otherwise.

The results of the test are presented in Table 2.5. For the sake of brevity, we only report the coefficients and standard errors of year-indicators. For all employee pay specifications, the $Year^{-1}$ coefficients are not statistically distinguishable from zero. Whereas the $Year^{+1}$ and $Year^{>=+2}$ coefficients are positive and significant for both non-executive and executive (total and equity-based pay) samples. The CDS effect becomes stronger over time for all employee pay specifications. Overall, these findings indicate that the increase in employee pay appear just after CDS trading begins, justifying forward causality emanating from the inception of CDS trading to employee pay policy. In addition, we find that the effect of CDS trading on executive compensation manifests faster than on average employee pay given the positive and statistically significant coefficients for $Year^{0}$ in the CEO pay (total and equity-based) samples. That might be explained by the unique position of CEO in corporate structure compared with general workers, and the presence of different mechanisms through which CDS trading might affect compensation of workers.

Table 2.5: **CDS trading and employee pay: Test on reverse causality.** This table presents the coefficients and standard errors obtained from the baseline regression with $CDSTrading$ replaced by four dummy variables $Year^{-1}$, $Year^{0}$, $Year^{+1}$ and $Year^{>=+2}$, for the average (non-executive) employee pay sample and the CEO pay sample during 1996-2013. $Year^{-1}$ is an indicator that equals one if CDS trading will be initiated in one year and zero otherwise. $Year^{0}$ is an indicator that equals one if CDS trading is initiated this year and zero otherwise. $Year^{+1}$ ($Year^{>=+2}$) is an indicator that equals one if CDS trading was initiated one (two or more) year(s) ago and zero otherwise. The coefficients of control variables are not tabulated. The definitions of variables are presented in Appendix 2.A1. Industry and year fixed effect are controlled. Industry group is defined by the first two digits of the SIC code. The standard errors presented in parentheses are robust to heteroskedasticity and clustered by firm level. The symbols ***,**, and * denote significance levels of 1%, 5%, and 10%, respectively.

Variables	(1) Average employee pay	(2) CEO Total pay	(3) CEO Salary	(4) CEO Bonus	(5) CEO Equity pay
$Year^{-1}$	0.04	0.06	0.01	0.04	0.09
	(0.03)	(0.03)	(0.01)	(0.04)	(0.04)
$Year^{0}$	0.05	0.09^{***}	0.01	0.02	0.16^{***}
	(0.03)	(0.03)	(0.01)	(0.04)	(0.04)
$Year^{+1}$	0.07^{**}	0.12^{***}	0.03	0.06	0.20^{***}
	(0.04)	(0.03)	(0.01)	(0.04)	(0.05)
$Year^{>=+2}$	0.10^{***}	0.14^{***}	-0.02	0.11^{*}	0.26^{***}
	(0.04)	(0.03)	(0.01)	(0.04)	(0.04)
Observations	12,143	28,847	29,024	15,227	23,573
R-squared	0.52	0.54	0.59	0.42	0.50
CEO characteristics	NO	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES
Clustered SE	YES	YES	YES	YES	YES

The instrumental variable approach

To further mitigate the endogeneity concerns, we adopt the instrumental variable approach in the spirit of Subrahmanyam, Tang, and Wang (2014) and Saretto and Tookes (2013). Specifically, we use lenders' hedging activities on foreign exchange (FX) as an instrumental variable for CDS trading. Minton, Stulz, and Williamson (2009) document that lenders with larger foreign exchange hedging positions are more likely to hedge their credit risk using CDSs. An instrument is valid when it satisfies the relevance and exclusion conditions (Roberts and Whited, 2012). The relevance condition requires that the partial correlation between the instrument and the endogenous variable not be zero. That also applies in our case given the observed positive correlation between lending banks' FX hedging activities and banks' hedging demand for CDS contracts on their borrowers. In conjunction with the first condition, the exclusion restriction implies that the only role that the instrument plays in influencing the outcome (i.e., employee pay policy) of the baseline model is via its effect on the endogenous regressor (i.e., CDS trading). In our case, the proposed instrument is also likely to meet the required condition given the main purpose of FX derivatives to hedge foreign exchange risks, with its relation to macro risks rather than to firm-level risks. Consequently, we expect that a borrowing firm's employee pay policy should not be directly affected by lenders' hedging positions in FX derivatives.

To avoid forbidden regressions, we use the three-stage instrumental variable approach. The three-stage procedure has several advantages over two-stage instrumental variable approach by taking into account the binary nature of the endogenous variable and not requiring the first stage to be correctly specified. At the same time, the standard errors of the standard IV approach remain asymptotically valid (Wooldridge, 2010, p.623).

In the first stage, we estimate the probability of *CDS Trading* using *Lender FX Hedging* as an instrument in the logit model in Eq. (2.2). We construct the instrument as the average notional amount of foreign exchange derivatives used for hedging purposes relative to the bank's total assets across all bank lenders and bond underwrites that a firm has borrowed from over the past five years. The results of the first stage are reported in the second column of Table 2.A2. The instrument positively and significantly predicts *CDS Trading*, suggesting that the instrument satisfies the relevance condition. In addition, we can reject the hypothesis of a weak instrument given that p-value is less than 0.01 and Sargan F-test statistic is above 10. In the second and third stages, we run the standard two-stage least squares (2SLS) approach with the fitted value of *CDS Trading* resulting from the first stage as the instrument, that allows us to mitigate the possible effect of misspecification in the first-step logit model. The final results with the instrumented CDS trading variable are presented in Table 2.6. We again find positive and significant effects of CDS introduction on employee pay. Consistent with the baseline results, the growth in total CEO compensation is mainly driven by the increase in equity-based pay.

Table 2.6: **CDS trading and employee pay: Instrumental variable approach.** This table presents the results of the third stage estimation of the instrumental variable approach for the employee pay samples during 1996-2013. The instrument is *Lender FX Hedging* defined as a measure of the foreign exchange derivative activities aimed at hedging purposes of the firm's lenders and bond underwriters over the past five years. The coefficient of the interest is *Instrumented CDS Trading* estimated from the instrumental variable based on the "Model 2" presented in Appendix 2.A2. We use the same control variables as we use in the baseline regressions. The definitions of variables are presented in Appendix 2.A1. Industry and year fixed effect are controlled. Industry group is defined by the first two digits of the SIC code. The standard errors presented in parentheses are robust to heteroskedasticity and clustered by firm level. The symbols ***,**, and * denote significance levels of 1%, 5%, and 10%, respectively.

Variables	(1) Average employee pay	(2) CEO Total pay	(3) CEO Salary	(4) CEO Bonus	(5) CEO Equity pay
Instrumented CDS Trading	0.21**	0.25***	-0.04	0.02	0.15**
	(0.09)	(0.08)	(0.03)	(0.10)	(0.07)
Firm size	0.05***	0.42***	0.17***	0.36***	0.49***
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Leverage	0.11	0.80***	0.49***	0.75***	0.80***
	(0.07)	(0.06)	(0.03)	(0.09)	(0.07)
MB	-0.01	-0.04***	-0.06***	-0.06***	0.02***
	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)
Sales/employee	0.00***				
	(0.00)				
PCI	-0.03				
	(0.05)				
TRS		0.01***	(0.00)	0.02***	0.01*
		(0.00)	(0.00)	(0.00)	(0.00)
Constant	3.11***	4.61***	4.75***	2.87***	3.73***
	(0.09)	(0.15)	(0.05)	(0.16)	(0.13)
Observations	10,877	25,176	25,161	13,169	20,693
R-squared	0.54	0.41	0.58	0.41	0.49
CEO characteristics	NO	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES
Clustered SE	YES	YES	YES	YES	YES

2.4.3. Missing data on total labor expenses

In addition to controlling for the selection of firms into the CDS traded sample, we also address a potential-selection bias created by missing information on total labor costs in Compustat for the average employee pay sample. Specifically, to control whether firms are selective in their decision to report their labor expenses, we adopt a Heckman (1979) two-step analysis. To do this, we first estimate a probit model of the firm-level probability of reporting labor expenses:

$$Reporting_{i,t} = \beta_0 + \beta_1\, X_{i,t} + \beta_2\, Exchange_{i,t} + \beta_3\, Industry_{i,t} + \beta_4\, Year_t + \epsilon_{i,t}, \quad (2.3)$$

where *Reporting* is the dependent indicator variable equal to one if the data on labor costs are non-missing and zero otherwise. We follow Chemmanur, Cheng, and Zhang (2013) and include the dummies of the firms' listing exchange (*Exchange*) and a set of control variables X. Chemmanur, Cheng, and Zhang (2013) show that *Exchange*, as a chosen instrument, meets both the relevance and the exclusion conditions through different reporting behavior across firms on different exchanges and no effect on the magnitude of reported average employee compensation. The results of the first-stage analysis presented in column (1) in Table 2.7 confirm this assumption. Listing exchange dummies are jointly significant. The coefficients of other control variable are also consistent with prior literature.

Next, based on the first stage, we calculate the predicted Inverse Mills ratio (Lambda) and include it as a predictor in Eq. (2.1) (Wooldridge, 2010). The results of the second stage are reported in column (2) in Table 2.7. We find further evidence of positive and significant effect of CDS trading on average employee pay. Whereas the significant coefficient for Lambda implies that its inclusion is necessary to mitigate the sample selection bias.

Table 2.7: **CDS trading and average employee pay: Heckman two-step analysis.** This table presents the coefficients and standard errors obtained from a Heckman two-step analysis for the average (non-executive) employee pay sample during 1996-2013. The first stage estimates a probit model with the dependent variable equal to one if the data on labor expenses are non-missing and zero otherwise. In addition to the control variables used previously, we also include the dummies of the firm's listing exchange. In the second stage, we examine the effect of CDS trading on average employee pay. The coefficient of interest is $CDS\,Trading$ which is a dummy variable that equals one if a firm has a CDS trading on its debt during a year and zero otherwise. The Inverse $Mills\,Ratio\,(Lambda)$ derived from the probit model is included as a regressor in the second stage. The definitions of variables are presented in Appendix 2.A1. Industry and year fixed effect are controlled. Industry group is defined by the first two digits of the SIC code. The standard errors presented in parentheses are robust to heteroskedasticity and clustered by firm level. The symbols ***,**, and * denote significance levels of 1%, 5%, and 10%, respectively.

Variables	(1) First stage: Reporting	(2) Second stage: Average employee pay
CDS Trading		0.09***
		(0.03)
CDS Firm		0.14***
		(0.03)
Firm size	0.18***	0.05***
	(0.00)	(0.00)
Leverage	0.52***	0.09***
	(0.02)	(0.03)
MB	-0.04***	-0.00
	(0.00)	(0.00)
Sales/employee	0.00	0.00***
	(0.00)	(0.00)
PCI	0.20***	-0.09***
	(0.01)	(0.02)
Exchange dummies	Jointly significant	
Inverse mills ratio (Lambda)		-0.12***
		(0.03)
Constant	-2.57***	3.37***
	(0.07)	(0.28)
Observations	87,321	87,321
Censored observations	75,178	75,178
Uncensored observations	12,143	12,143
Year FE	YES	YES
Industry FE	YES	YES
Clustered SE	YES	YES
Wald chi-square (p-value)	12,248.04	12,248.04
	(0.00)	(0.00)

2.5. Channels and Total Labor Welfare

In this section, we conduct a number of tests to investigate the potential channels through which CDSs can affect employee pay policy, including both human capital risk channel and interest-alignment channel. We also examine whether the effect of CDSs goes beyond wages and affects overall labor welfare, representing general employee relationship and working conditions in firms.

2.5.1. Unemployment risk

Workers face nontrivial costs from unemployment. Employees with greater concerns on human capital risk are more likely to demand a higher compensation ex ante in response to the increased probability of corporate bankruptcy (Berk, Stanton, and Zechner, 2010; Jaggia and Thakor, 1994; Titman, 1984). We identify settings when the human capital risk concern is more severe and compare the effect of CDSs among firms with low and high concerns based on layoff propensity, workers' costs during unemployment, and delay before re-employment. We expect a stronger effect of CDSs on employee base compensation (i.e., wages and salaries) when labor has greater exposure to unemployment risk, which is consistent with the "human capital risk" channel.

Specifically, we first examine the cross-industry heterogeneity in the propensity to lay off workers. The long-run propensity for layoffs based on systematic differences across industries can affect the workers' expected exposure to unemployment risk. Employees in industries with high layoff rates are exposed to greater unemployment risk. Following Agrawal and Matsa (2013), we measure layoff separation rates as the ratio of workers affected by mass layoffs to total industry employment for three-digit NAICS industries. The layoff separation rates show significant variations across industries with the average value of 1.5% and the median of 0.8%. The lowest layoff rates (below 0.1%) are in industries such as real estate, educational services, various health care and social assistance, gasoline stations and auto parts dealers. The highest layoff rates are in agriculture and forestry support activities (18.4%), passenger ground transportation (5.9%), and heavy and civil engineering construction (5.7%).

Second, we measure workers' exposure to unemployment risk by costs borne by workers during unemployment period. To determine these costs, we use unemployment insurance (UI) benefits across US states. According to the UI system of the

United States, workers who have become unemployed through no fault of their own are able to receive unemployed benefits (temporary income) during a specified period of time. However, UI benefits vary across states in wage benefit amounts and duration of time during which unemployed worker is eligible to receive weekly payments. That allows us to split our sample between firms located in less and more generous state UI systems, where firms are assigned to a state according to the location of firms' headquarters.[15] Following Agrawal and Matsa (2013), we define the generosity of the state UI system as the product of the maximum amount of a weekly benefit payment and the maximum duration allowed eligible claimants to receive unemployment benefits. Employees in less generous state UI systems have higher costs during unemployment, that results in greater workers' exposure to unemployment risk.

Third, we split our sample based on potential delay in workers' re-employment. We rely on findings of previous studies documenting that workers in "new economy" firms can be reemployed faster than employees in other industries. For instance, Anderson, Banker, and Ravindran (2000) show that "new economy" firms competing in the computer, software, internet, telecommunications, or networking fields are characterized by stronger and intense demand for key managerial employees, and have a higher employee turnover than in other industries. That results in higher reduction in human capital of employees working in "old economy" bankrupt firms compared to those working in "new economy" bankrupt firms. We follow Anderson, Banker, and Ravindran (2000) and define "new economy" firms as those in the hardware, software and telecommunications (see Appendix 2.A1 for detailed classification). "Old economy" firms are defined as the rest of the firms in our sample.

We then reestimate Eq. (2.1) separately for different levels of workers' expected exposure to unemployment risk: industries with high and low layoff separation rates, less and more generous states, "new economy" and "old economy" firms. The results are presented in Table 2.8. As expected, we find that the effect of CDSs on average employee pay increases with workers' exposure to unemployment risk. Specifically, regular workers demand higher compensation following the introduction of CDSs in industries in which layoffs occur with high frequency and in "old economy" firms, which are characterized by longer delay in workers' re-employment. In addition, following the onset of CDS trading, we find the more pronounced increase in employee base pay for non-executive workers in the states providing low unemployment insurance benefits, that creates higher costs to workers during the unemployment period.

[15] In the spirit of Agrawal and Matsa (2013), given the fact that some workers of firms can be located in different states than firms' headquarters, we exclude industries with large percentage of geographically dispersed workforce (e.g., retail, wholesale and transport).

Table 2.8: **CDS trading and employee pay: Unemployment risk.** This table demonstrates the CDS - base pay relation estimated from the baseline regression for different levels of workers' exposure to unemployment risk. *Panel A* measures workers' exposure to unemployment risk by industry propensity to lay off workers. Industries with high (low) layoff propensity are represented by industries above (below) median layoff separation rate. *Panel B* measures workers' exposure to unemployment risk by generosity of state unemployment insurance (UI) benefit laws, representing costs borne by workers during unemployment period. Low (high) state generosity is represented by states with low (high) UI benefits, i.e. below (above) the 70th percentile. *Panel C* splits sample by "new economy" firms and "old economy" firms. "Old economy" firms are characterized by longer delay in workers' re-employment than "new economy" firms. We use the same control variables, including $CDS\,Firm$, as we use in the baseline regressions. *% CDS* is the percentage of CDS firms in subsamples. Industry and year fixed effect are controlled. The standard errors presented in parentheses are robust to heteroskedasticity and clustered by firm level. The symbols ***,**, and * denote significance levels of 1%, 5%, and 10%, respectively.

	Average employee pay		CEO Salary	
Panel A: Industry layoff propensity				
	Low	High	Low	High
	(1)	(2)	(3)	(4)
CDS Trading	0.01	0.12**	-0.04	0.19*
	(0.05)	(0.07)	(0.07)	(0.11)
Observations	5,044	4,534	9,311	12,569
% CDS	10%	14%	32%	30%
R-squared	0.76	0.57	0.52	0.50
Panel B: Generosity of state UI benefit laws				
	Low	High	Low	High
	(1)	(2)	(3)	(4)
CDS Trading	0.13**	0.09	0.04*	-0.01
	(0.06)	(0.06)	(0.02)	(0.02)
Observations	1,908	1,873	11,285	11,715
% CDS	21%	25%	35%	29%
R-squared	0.61	0.75	0.55	0.58
Panel C: "New economy" firms vs. "old economy" firms				
	New	Old	New	Old
	(1)	(2)	(3)	(4)
CDS Trading	-0.15	0.10***	-0.16	0.02
	(0.12)	(0.04)	(0.10)	(0.02)
Observations	1,455	11,010	4,029	24,799
% CDS	5%	13%	20%	34%
R-squared	0.45	0.66	0.44	0.56

Interestingly, while the baseline results suggest no significant change in CEO base salary after the onset of CDS trading on the debt of the average firm, we find some evidence of the positive CDS effect on CEOs' salaries in industries with high layoff propensity and US states providing low UI benefits.

2.5.2. Employee bargaining power

We further examine the CDS-wage relation for different levels of worker-firm bargaining environment. We measure an employee bargaining power by a percent of employed workers who are covered by a collective bargaining agreement based on data from the Union Membership and Coverage Database. Given the fact that employees at unionized workplaces on average earn higher wages than non-unionized labor (e.g., see Blanchflower and Bryson, 2003), we expect that workers in firms operating in highly unionized industries (i.e., with higher barging power) should be more successful in demanding a higher compensating wage based on employment protection incentives in response to the growth in firm default risk following the CDS introduction.

Table 2.9: **CDS trading and employee pay: Employee bargaining power.** This table demonstrates the CDS - base pay relation estimated from the baseline regression for different levels of the worker-firm bargaining environment. We measure employee bargaining power across industries by a percent of employed workers who are covered by a collective bargaining agreement, based on data of the Current Population Survey (CPS). Industries with high (low) employee bargaining power are represented by industries above (below) median union coverage. We use the same control variables, including $CDS\,Firm$, as we use in the baseline regressions. *% CDS* is the percentage of CDS firms in subsamples. Industry and year fixed effect are controlled. The standard errors presented in parentheses are robust to heteroskedasticity and clustered by firm level. The symbols ***,**, and * denote significance levels of 1%, 5%, and 10%, respectively.

	Average employee pay		CEO Salary	
	Low	High	Low	High
	(1)	(2)	(3)	(4)
CDS Trading	0.03	0.12^{***}	-0.05^{**}	0.03^{**}
	(0.06)	(0.05)	(0.02)	(0.01)
Observations	4,863	7,280	11,521	17,503
% CDS	7%	10%	19%	25%
R-squared	0.69	0.33	0.49	0.64

To test this hypothesis, we estimate the impact of CDS trading on employee base pay (average employee pay and CEOs' salaries) in firms operating in industries with high and low employee bargaining power (i.e., above and below median union coverage), respectively. The results tabulated in Table 2.9 demonstrate a positive and highly significant effect of CDS trading on average employee pay in highly unionized industries associated with greater employee bargaining power. Different from the baseline results, we find a positive and statistically significant effect of CDSs on CEO salaries in firms operating in highly unionized industries. For firms operating in industries with low union coverage, the coefficients on *CDS Trading* for the base pay of general workers are positive, but not statistically significant. In this setting, there is even some evidence of decrease in CEO base salary after CDS introduction.

2.5.3. Managerial incentives

In this section, we investigate the effect of CDS introduction on CEO incentives. Consistent with the "interest alignment" channel discussed above, to take advantage of the relaxed financing constraints and increased lenders' risk tolerance following the introduction of CDS trading, shareholders of CDS firms have an incentive to further align managers' interests and encourage their risk taking to maximize equity value. Thereby, in addition to the increased equity-based pay in CEOs' compensation structure, we expect the increase in the convexity of the relation between firm performance and CEO wealth (vega), that corresponds to greater risk-taking incentives.

Managerial incentives and corporate policy choices can be jointly determined (Coles, Daniel, and Naveen, 2006). Given the potential causation, the estimation of ordinary least squares (OLS) with regressors endogenously determined along with the dependent variable will produce biased parameter estimates. To account for the CDS effect on the structure of CEOs' compensations and corresponding incentives, we follow Coles, Daniel, and Naveen (2006) and estimate simultaneous systems of equations (3SLS) in which the jointly determined variables are corporate policy choice, vega and delta:

$$\begin{aligned} Policy_{i,t} &= \beta_{10} + \beta_{11}\, CDS\,Trading_{i,t} + \beta_{12}\, Vega_{i,t} + \beta_{13}\, Delta_{i,t} + \beta_{14}\, X_{i,t} + \epsilon_{i,t}, \\ Vega_{i,t} &= \beta_{20} + \beta_{21}\, CDS\,Trading_{i,t} + \beta_{22}\, Policy_{i,t} + \beta_{23}\, Delta_{i,t} + \beta_{24}\, X_{i,t} + \epsilon_{i,t}, \\ Delta_{i,t} &= \beta_{30} + \beta_{31}\, CDS\,Trading_{i,t} + \beta_{32}\, Policy_{i,t} + \beta_{33}\, Vega_{i,t} + \beta_{34}\, X_{i,t} + \epsilon_{i,t}, \end{aligned} \tag{2.4}$$

where *Policy* is defined as either *R&D* (research and development expenses scaled by assets) or *Leverage*. Control variables for each single equation in Eq. (2.4) have been chosen in the spirit of Coles, Daniel, and Naveen (2006). For identification in the simultaneous equations model, we use industry variables as determinants for corporate policy choices and managerial incentives. As previously, we control for industry and year fixed effects, and unobservable time-invariant fundamental differences between CDS and non-CDS firms by including *CDS Firm* variable. Definitions of all variables used in Eq. (2.4) are presented in Appendix 2.A1.

The results of the estimation are reported in Table 2.10. Consistent with prior literature, we find that corporate debt and investment policies are intertwined with managerial incentives, as evidenced by significant coefficients for R&D, leverage, vega and delta. Leverage and R&D investment positively (negatively) affect vega (delta), and vice versa. More importantly, leverage, R&D and vega increase following the onset of CDS trading in the joint estimation. The coefficients for *CDS Trading* are positive and statistically significant at the 1%. The increase in the sensitivity of CEO wealth to stock return volatility (vega) post CDS inception corresponds to the reduced managers' aversion to take "riskier" policy choices, i.e. in the form of higher firm leverage and more investments in innovation.

2.5.4. Labor welfare

The effect of CDSs on human capital of general workers can be broader than just the effect on their base pay. In addition to base wages, compensation of workers can be in the form of any additional non-contractual employee benefits and general improvements of working conditions. Firms have a desire to keep and maintain their reputation for treating employees fairly given the value human capital can create, particularly for those emphasizing quality and innovation (Edmans, 2011; Liu, Mao, and Tian, 2017). The relaxed financing constraints and increased lenders' risk tolerance after CDS introduction can encourage CDS firms to improve employee welfare to motivate employees better for value maximizing efforts.[16] Furthermore, providing additional employee benefits can minimize voluntary turnover of workers induced by their concerns on employers' stability.

[16]Consistent with the improved employee welfare and motivations, Chang, Chen, Wang, Zhang, and Zhang (2019) find that CDSs increase corporate innovation outputs and innovation efficiency.

Table 2.10: **CDS trading and managerial incentives.** This table reports the coefficients and standard errors obtained from the simultaneous equations (3SLS) of corporate policy choice (Leverage or R&D) and CEO incentives (Vega and Delta) for the CEO pay sample during 1996-2013. Models (1)-(3) are for leverage and CEO incentives. Models (4)-(6) are for R&D and CEO incentives. The coefficient of interest is $CDS\,Trading$, which captures the impact of the inception of CDS trading on corporate policy choice, vega and delta. See Appendix 2.A1 for variable definitions. The symbols ***,**, and * denote significance levels of 1%, 5%, and 10%, respectively.

	Panel A: Leverage and incentives			*Panel B: R&D and incentives*		
	(1)	(2)	(3)	(4)	(5)	(6)
Variables	Leverage	Vega	Delta	R&D	Vega	Delta
CDS Trading	0.08***	0.14***	-0.09***	0.01***	0.23***	0.03
	(0.01)	(0.04)	(0.03)	(0.00)	(0.03)	(0.03)
CDS Firm	0.03***	-0.18***	-0.20***	0.00	-0.13***	-0.13***
	(0.01)	(0.03)	(0.03)	(0.00)	(0.03)	(0.02)
Vega	0.06***		0.21***	0.01***		0.23***
	(0.01)		(0.03)	(0.00)		(0.03)
Delta	-0.01	0.08***		-0.01***	0.07***	
	(0.01)	(0.02)		(0.00)	(0.02)	
Leverage		1.60***	-1.46***	-0.04***	0.15**	-0.27***
		(0.24)	(0.19)	(0.00)	(0.06)	(0.05)
R&D	-0.12***	1.79***	-0.53***		3.33***	-2.46***
	(0.02)	(0.14)	(0.12)		(0.96)	(0.74)
Industry Vega		0.62***			0.51***	
		(0.03)			(0.03)	
Industry Delta			0.52***			0.37***
			(0.02)			(0.02)
Industry Leverage	0.75***					
	(0.03)					
Industry R&D				1.00***		
				(0.07)		
Firm size	0.01	0.54***	0.50***	0.00	0.51***	0.44***
	(0.01)	(0.01)	(0.02)	(0.00)	(0.01)	(0.02)
MB	0.07***	0.03	0.32***	0.02***	-0.10***	0.23***
	(0.00)	(0.02)	(0.01)	(0.00)	(0.02)	(0.01)
CAPEX		-0.14	0.66***		-0.26	0.80***
		(0.17)	(0.14)		(0.17)	(0.13)
Return volatility		0.04***	-0.02		0.04***	-0.03
		(0.03)	(0.03)		(0.07)	(0.05)
CEO Tenure	0.00		0.06***	0.00**		0.06***
	(0.00)		(0.00)	(0.00)		(0.00)
CEO Cash compensation	0.06***	0.23***		0.00	0.33***	
	(0.00)	(0.02)		(0.00)	(0.02)	
Observations	18,172	18,172	18,172	18,172	18,172	18,172
Year FE	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Clustered SE	YES	YES	YES	YES	YES	YES

We construct our firm-level labor welfare measures using Environmental, Social and Corporate Governance (ESG) performance data from MSCI ESG STATS database. It covers the 3000 largest publicly traded U.S. companies (Russell 3000) by market capitalization since 2003. The data have been widely used for evaluating firms' strengths and concerns in employee relations (e.g., Bae, Kang, and Wang, 2011; DiGiuli and Kostovetsky, 2014).[17]

To measure labor welfare, we follow Bae, Kang, and Wang (2011) and use five positive performance indicators of employee relations, including 1) union relations, i.e. the company has taken exceptional steps to treat its unionized workforce fairly; 2) cash profit sharing, i.e. the company has a cash profit sharing program through which it has recently made distributions to a majority of its employees; 3) employee involvement, i.e. the company strongly encourages worker involvement and/or ownership through stock option plans, gain sharing, sharing of financial information, or participation in management decision making; 4) retirement benefits strength, i.e. the company has a notably strong retirement benefits program; and 5) health and safety strength, i.e. the company has a strong health and safety program. The sum of these five categories, each rated 0 or 1, gives our baseline firm-level labor welfare measure. By construction, better labor welfare manifests in a higher value with the maximum score of five. In total, there are 12,197 firm-year observations during 2003-2009 that have non-missing values for each category of employee relations used in the calculation of the baseline labor welfare measure. The sample ends in 2009 since the rating for "retirement benefits strength" discontinued after that. As a robustness check, we calculate the labor welfare measure using the remaining four ratings categories, excluding "retirement benefits strength", with an extended sample period of 2003-2013.

Table 2.11 Panel A presents the results of the effect of *CDS Trading* on corporate labor welfare. Column (1) measures labor welfare using the sum of all five rating categories. Although the sample period for labor welfare is shorter than for the baseline analysis of employee pay, the sample includes 524 firms that have CDS trading initiated on their debt. The coefficient estimate for *CDS Trading* is positive and statistically significant at the 1% level, suggesting that firms' labor welfare improves

[17] ESG STATS provides extensive information on the ratings with respect to firm-level social performance in seven major qualitative areas: environmental impact, community relations, corporate governance, workforce diversity, employee relations, human rights, and product quality and safety. The ratings are assigned based on direct communication with company officers and scanning public databases, including company filings, government data and general media sources. ESG STATS is previously known as KLD STATS. Prior to 2003, it only covers S&P 500 companies since 1991.

following the introduction of CDS trading on their debt.[18] Column (2) measures the labor welfare as the sum of four employee relation rating categories available during 2003-2013. Columns (3) and (4) further address the endogeneity of CDS trading using propensity score matching and IV approaches as discussed in Section 2.4.2. We again find the increase in labor welfare after CDS contracts start trading on firms' debt.

Table 2.11 Panel B further investigates the effect of CDSs on each individual employee relation rating category for additional implications of the channels. We find interesting variations of the CDS effect on different aspects of employee welfare measure. The increase in labor welfare after the introduction of CDSs mainly comes from better scores for "cash profit sharing" and "health and safety" indicators. There is some evidence of increase in "employee involvement", although the change is only marginally significant. These results demonstrate a firm's incentive to improve interest alignments through increasing workers' efforts and productivity. Furthermore, broad-based profit sharing payments give a positive signal to workers regarding firms' financial stability and current profitability. That might partly alleviate employees' concerns on human capital risk associated with the increased firms' default probability, and enhance employment stability through minimizing voluntary turnover.[19] Together with the average employee pay findings in previous sections, we find evidence that CDSs improve wealth and working conditions for general workers.

2.5.5. Other tests

In appendix 2.A4 - 2.A5, we also examine the role of default risk and financial constraints in the CDS effect on employee pay. As a measure of default risk, we use Atman's Z-score, with low values indicating high default risk. To measure the tightness of firm's financial constraints, we use WW index (Whited and Wu, 2006) and firm size. The prior literature indicates that smaller firms and firms with a high WW index are more likely to face difficulty in raising external financing.

[18]The coefficient estimate for *CDS Firm* has an opposite sign, however it is not statistically significantly different from zero. The results of Table 2.11 indicate that CDS firms do not fundamentally differ in terms of labor welfare from non-CDS firms, however they experience a significant improvement in general working conditions in the years following CDS introduction.

[19]The current literature on compensation of non-executive workers provides mixed evidence on the use of broad-based plans, such as profit-sharing and stock option grants, just for effort and productivity enhancement reasons (e.g., see Kandel and Lazear, 1992; Kim and Ouimet, 2014; Oyer, 2004). Many studies argue that free-riding among employees can outweigh any incentive motives of compensation based on collective firm's performance. Instead, it can be used to retain workers and enhance employment stability (e.g., see Kruse, 1993; Oyer, 2004).

Table 2.11: **CDS trading and labor welfare.** This table presents the estimation of the effect of CDS trading on labor welfare measures. *Panel A* reports the baseline results (column 1), propensity score matching results (column 3), results of the instrumental variable approach (column 4) for the baseline labor welfare measure, which is constructed based on five positive performance indicators of employee relations during 2003-2009 from MSCI ESG STATS database. There are 524 firms in the sample that have CDS trading initiated on their debt. Column 2 shows the baseline results for the alternative measure of the labor welfare during 2003-2013, which excludes the "retirement benefits" indicator from the calculation given termination in its reporting after 2009. The sample for the alternative measure includes 564 firms that have CDS trading initiated on their debt. *Panel B* presents the estimates of the firm's probability of receiving positive performance indicators for each individual component of the employee relations. The definitions of variables are presented in Appendix 2.A1. Industry and year fixed effect are controlled. Industry group is defined by the first two digits of the SIC code. The standard errors presented in parentheses are robust to heteroskedasticity and clustered by firm level. The symbols ***,**, and * denote significance levels of 1%, 5%, and 10%, respectively.

Panel A: Labor welfare

	Labor welfare			
	(1)	(2)	(3)	(4)
CDS Trading	0.19***	0.16**	0.21***	
	(0.07)	(0.06)	(0.08)	
Instrumented CDS Trading				0.38***
				(0.10)
CDS Firm	-0.01	-0.07	-0.19	
	(0.07)	(0.06)	(0.11)	
Firm size	0.10***	0.10***	0.23***	0.08***
	(0.01)	(0.01)	(0.05)	(0.01)
Leverage	0.05	0.01	-0.01	0.08
	(0.05)	(0.05)	(0.27)	(0.06)
MB	-0.01	-0.00	0.02	0.00
	(0.01)	(0.00)	(0.05)	(0.01)
Sales/employee	0.00***	0.00	0.00**	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)
PCI	0.14***	0.10***	0.50***	0.15***
	(0.03)	(0.03)	(0.11)	(0.03)
Constant	-0.61***	-0.57***	-1.62***	-0.40***
	(0.07)	(0.08)	(0.41)	(0.07)
Observations	12,197	13,139	2,356	11,560
R-squared	0.20	0.21	0.30	0.22
Year FE	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Clustered SE	YES	YES	YES	YES

Table 2.11 **- Continued**

Panel B: Individual components of labor welfare measure

Variables	(1) Union relations	(2) Cash profit sharing	(3) Employee involvement	(4) Retirement benefits	(5) Health and safety
CDS Trading	-0.24	0.38***	0.11*	0.06	1.33***
	(0.15)	(0.07)	(0.06)	(0.08)	(0.42)
CDS Firm	-0.06	-0.31***	-0.07	0.29***	-0.97**
	(0.15)	(0.06)	(0.06)	(0.08)	(0.42)
Firm size	0.25***	0.20***	0.23***	0.11***	0.56***
	(0.03)	(0.02)	(0.01)	(0.02)	(0.03)
Leverage	0.55***	0.02	-0.43***	-0.27**	0.30*
	(0.17)	(0.11)	(0.10)	(0.13)	(0.17)
MB	-0.22***	0.01	-0.01	-0.01	-0.24***
	(0.05)	(0.01)	(0.01)	(0.02)	(0.04)
Sales/employee	0.00	0.00***	0.00**	0.00***	-0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
PCI	0.62***	0.45***	0.10*	0.57***	0.41***
	(0.09)	(0.06)	(0.05)	(0.07)	(0.08)
Constant	-3.80***	-2.42***	-2.73***	-2.09***	-5.64***
	(0.41)	(0.25)	(0.33)	(0.32)	(0.37)
Observations	13,982	17,054	17,846	13,562	16,817
Pseudo R-squared	0.41	0.17	0.15	0.18	0.36
Year FE	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES
Clustered SE	YES	YES	YES	YES	YES

We find greater effect of CDSs on average employee pay in more financially constrained firms and those with greater default risk. The findings are consistent with the "human capital risk" channel.[20]

With respect to the "interest alignment" channel, we expect a higher shareholders' incentive to align their interests with executive workers in safer firms, that can benefit more from the introduction of CDS trading in terms of decreased borrowing costs and relaxed financing constraints (Ashcraft and Santos, 2009). As expected, we find greater increase in CEO equity-based pay post CDS inception in financially constrained firms with lower default risk.

[20]Agrawal and Matsa (2013) emphasize that firms' financing frictions are associated with higher unemployment risk, that encourages workers to demand higher wage premiums. The inability of firms to raise external financing, that can be used to buffer negative economic shocks instead laying off workers, raises workers' concerns on human capital risk (Ofek, 1993).

2.6. Conclusion

This study provides a comprehensive assessment of the effect of CDSs on human capital. Using a large sample of U.S. firms, we find the increase in average employee pay and CEOs' total pay by 8% and 10% respectively, following the introduction of CDS trading on firms' debt. These results persist even after addressing the potential endogeneity of CDS introduction using propensity score matching, reverse causality test, and instrumental variable estimations.

Consistent with employees' concerns on human capital risk, we find the more pronounced positive effect of CDSs on employee base pay in firms with higher employee bargaining power and greater workers' exposure to unemployment risk. Furthermore, we find that regular workers in the average firm with traded CDSs are more concerned about risk of losing their job than executives. On the contrary, the growth of CEOs' compensation is mainly driven by equity-based pay with higher vega in the compensation structure. Using ratings on employee relationship from ESG STATS, we find the increase in overall labor welfare after CDS introduction, particularly for firm-level ratings on broad-based cash profit sharing, and health and safety benefits. While our baseline measure of compensation of regular workers is dominated by the fixed (performance insensitive) part, the increased labor welfare post CDS inception suggests firms' efforts in better treating and motivating both executive and non-executive employees. Furthermore, broad-based profit sharing schemes minimize voluntary turnover in firms by partly reducing workers' concerns on employers' stability.

Previous literature have documented both the positive and negative effects of CDSs on reference firms and other financial stakeholders (Augustin, Subrahmanyam, Tang, and Wang, 2016). Our study contributes to the understanding of the real effects of CDSs on corporate non-financial stakeholders. Our findings of the positive effect of CDSs on human capital, a firm's asset not listed in the balance sheet but bringing essential economic value to the firm's business and the economy as a whole, can be useful for policymakers in discussion regarding the welfare effects of the CDS market.

2.7. Appendix

Table 2.A1: **Variable definitions**

Variable	Description
CDS variables	
CDS Trading	A dummy variable that equals one in and after the year of inception of CDS trading on a reference firm's debt. *Source: CreditTrade, GFI, Markit*
CDS Firm	A dummy variable that equals one if the firm has CDS trading on its debt at any time during the sample period 1996-2013. *Source: CreditTrade, GFI, Markit*
Instrumented CDS Trading	A dummy variable of CDS trading estimated by the instrumental variable (IV) approach.
Lender FX hedging	The instrument in the IV approach. The average notional amount of foreign exchange derivatives used for hedging (not trading) purposes to the bank's total assets across all banks, lenders and bond underwrites, a firm has borrowed from over the past five years. *Source: DealScan, FISD, Federal Reserve Call Reports*
Employee pay	
Average employee pay	Total labor expense divided by number of employees. *Source: Compustat*
CEO Total pay	Salary + Bonus + Other annual + Restricted stock grants + LTIP (long-term incentive plan) + All other + Value of option granted. *Source: ExecuComp*
CEO Salary	Salary. *Source: ExecuComp*
CEO Bonus	Bonus. *Source: ExecuComp*
CEO Equity-based pay	Options granted + Restricted stock grant. *Source: ExecuComp*
Labor welfare measure	The sum of five positive performance 0/1 indicators of employee relations: union relations + cash profit sharing + employee involvement + retirement benefits strength + health and safety. Better labor welfare (higher investment in employee well-being) manifests in higher score, with the maximum score of five. *Source: MSCI ESG STATS database created by KLD Research & Analytics*
CEO characteristics	
Male	A dummy variable equal to one if the CEO is male. *Source: ExecuComp*
Age	Age of the CEO. *Source: ExecuComp*
Tenure	Number of years in CEO position in a particular firm. *Source: ExecuComp*
Chairman	A dummy variable equal to one if the CEO is also the chairman. *Source: ExecuComp*
Vega	The dollar change in the value of the CEO's wealth associated with a 0.01 change in the annualized stock return volatility. In the calculation, we follow steps provided by Coles, Daniel and Naveen (2013), who use the Black-Scholes (1973) option valuation model accounting for dividends (Merton, 1973). *Source: ExecuComp, CRSP, Compustat, FRED Economic Data*

Table 2.A1 **- Continued**

Variable	Description
Delta	The dollar change in the value of the CEO's wealth associated with a 0.01 change in the stock price. In the calculation, we follow steps provided by Coles, Daniel and Naveen (2013), who use the Black-Scholes (1973) option valuation model accounting for dividends (Merton, 1973). *Source: ExecuComp, CRSP, Compustat, FRED Economic Data*
Industry vega (delta)	The mean vega (delta) across all firms in the two-digit SIC code.
Firm characteristics	
Market capitalization	Market value of equity: stock price multiplied by number of shares outstanding at the end of a fiscal year. *Source: Compustat*
Firm size	Log (market capitalization). *Source: Compustat*
Leverage	Total debt to sum of total debt and market value of equity. *Source: Compustat*
MB	Market-to-book ratio: market value of assets divided to book value of assets. *Source: Compustat*
Sales/employees	Total amount of sales scaled by number of employees. *Source: Compustat*
PCI	Physical capital intensity: gross property plant, and equipment scaled by total assets. *Source: Compustat*
TRS	Total shareholder return: (stock price at year t - stock price at year t-1 + dividend per share)/stock price at year t-1. *Source: Compustat*
R&D	Research and development expenditure to assets. Missing values are replaced by zero. *Source: Compustat*
CAPEX	Net capital expenditure (capital expenditure - sale of property, plant and equipment) to assets. *Source: Compustat*
Return volatility	Log (standard deviation of daily stock returns estimated over 360 days prior the end of the fiscal period). *Source: CRSP*
ROA	Return on assets: operating income after depreciation to assets. *Source: Compustat*
Rated	A dummy variable that equals one if the firm has a Standard and Poor's (S&P) rating. *Source: Compustat*
Investment grade	A dummy variable that equals one if the firm has an investment grade rating, BBB or higher. *Source: Compustat*
Industry leverage (R&D)	The mean market leverage (R&D) across all firms in the two-digit SIC code.
Z-score	Altman's Z-score defined as *3.3 piq/atq + saleq/atq + 1.4 req/atq + 1.2 (actq-lctq)/atq*. *Source: Compustat*
WW index	WW Index defined as *-0.091 (ib + dp)/at – 0.062 (dividend indicator) + 0.021 dltt/at – 0.044 log(at) + 0.102 (average industry sales growth) – 0.035 (sales growth)*. *Source: Compustat*
Employee bargaining power	
Labor union coverage	Percent of employed workers who are covered by a collective bargaining agreement. *Source: "Union Membership and Coverage Database" constructed and updated annually by Barry Hirsch and David Macpherson based on the monthly household Current Population Survey (CPS) using BLS methods.*

Table 2.A1 **- Continued**

Variable	Description
Unemployment risk	
Generosity of state UI laws	Maximum amount of a weekly benefit payment $\times$ Maximum duration allowed eligible claimants to receive unemployment benefits. Companies with primary SIC designations of 4000-4800 (Transportation), 5000 - 5999 (Wholesale and Retail Trade) are excluded from the analysis given the large percentage of geographically dispersed workforce in these industries. *Source: Annual publications "Significant Provision of State UI Laws" by US Department of Labor*
Industry layoff propensity	Ratio of workers affected by mass layoffs to total industry employment. BLS defines workers affected by mass layoffs when at least 50 initial claims are filed against an institution during a consecutive five-week period and at least 50 workers have been separated from their jobs for more than 30 days. *Source: US Bureau of Labor Statistics "Mass Layoff Statistics" and the US Bureau of Economic Analysis*
"New economy" firms	Companies with primary SIC designations of 3570 (Computer and Office Equipment), 3571 (Electronic Computers), 3572 (Computer Storage Devices), 3576 (Computer Communication Equipment), 3577 (Computer Peripheral Equipment), 3661 (Telephone & Telegraph Apparatus), 3674 (Semiconductor and Related Devices), 4812 (Wireless Telecommunication), 4813 (Telecommunication), 5045 (Computers and Software Wholesalers), 5961 (Electronic Mail-Order Houses), 7370 (Computer Programming, Data Processing), 7371 (Computer Programming Service), 7372 (Prepackaged Software), and 7373 (Computer Integrated Systems Design).

Table 2.A2: **Probability of CDS trading.** This table presents the estimation of probability of CDS trading obtained by using a logit model. The sample period is 1996-2013 based on yearly observations. "Model 1" is used to estimate the firm-level probability of CDS trade initiation as a function of borrowing firms' characteristic for the propensity score matching analysis. "Model 2" is used to estimate the firm-level probability of CDS trade initiation for the first stage of the instrumental variable approach with *Lender FX Hedging* as an instrument. *Lender FX Hedging* is a measure of the foreign exchange derivative activities aimed at hedging purposes of the firm's lenders and bond underwriters over the past five years. Industry and year fixed effect are controlled. Industry group is defined by the first two digits of the SIC code. The standard errors presented in parentheses are robust to heteroskedasticity and clustered by firm level. The symbols ***,**, and * denote significance levels of 1%, 5%, and 10%, respectively.

Variables	Model 1	Model 2
Firm size	0.89***	0.91***
	(0.01)	(0.01)
Leverage	3.88***	3.95***
	(0.10)	(0.10)
MB	-0.31***	-0.30***
	(0.02)	(0.02)
Sales/employee	-0.00	-0.00
	(0.00)	(0.00)
PCI	-0.26***	-0.22***
	(0.05)	(0.06)
ROA	1.58***	1.31***
	(0.25)	(0.25)
Rated	2.04***	1.97***
	(0.20)	(0.20)
Investment grade	1.03***	0.98***
	(0.04)	(0.04)
Lender FX Hedging		56.03***
		(2.33)
Constant	-10.18***	-10.86***
	(0.34)	(0.35)
Observations	74,880	74,880
Pseudo R-squared	0.46	0.47
Year FE	YES	YES
Industry FE	YES	YES
Clustered SE	YES	YES

Table 2.A3: **CDS firms vs. non-CDS firms: Before/After propensity score matching.** This table compares differences in means of propensity scores and firm characteristics between CDS traded firms and non-CDS traded firms for the baseline samples (Before matching) and the propensity score matched sample (After matching). Propensity score matched firms are selected based on propensity scores estimated from the "Model 1" of prediction of the probability of CDS trading presented in Appendix 2.A2. The matching procedure is based on selection of one non-CDS firm with the nearest to each CDS firm's propensity score in the same industry and within of difference of 1%. In the matching procedure, the propensity scores are compared in the year prior to CDS trade initiation. We employ matching with replacement, when a non-CDS firm can be matched to multiple CDS firms. The definitions of variables are presented in Appendix 2.A1.The symbols ***,**, and * denote significance levels of 1%, 5%, and 10%, respectively.

Variables	Difference before matching (CDS Firm - Non-CDS Firm)	Difference after matching (CDS Firm - Non-CDS Firm)
Firm size	2.38^{***}	1.13^{***}
Leverage	0.09^{***}	0.05
MB	-0.19^{***}	-0.13
Sales/employee	36.08^{***}	10.57
PCI	0.03^{**}	0.03
TRS	0.00	0.00
Propensity score	0.26^{***}	0.05

Table 2.A4: **CDS trading and employee pay: Default risk.** This table presents the coefficients and standard errors obtained from the baseline regression. The coefficients of interest are *CDS Trading* and the interaction term *CDS Trading* $\times$ *Z-score*. The definitions of variables are presented in Appendix 2.A1. Industry and year fixed effect are controlled. Industry group is defined by the first two digits of the SIC code. The standard errors presented in parentheses are robust to heteroskedasticity and clustered by firm level. The symbols ***,**, and * denote significance levels of 1%, 5%, and 10%, respectively.

Variables	(1) Average employee pay	(2) CEO Salary	(3) CEO Bonus	(4) CEO Equity pay
CDS Trading	0.23***	0.04	0.22**	0.28***
	(0.06)	(0.03)	(0.10)	(0.06)
CDS Trading $\times$ Z-score	-0.06***	-0.00	-0.00	0.03***
	(0.02)	(0.01)	(0.03)	(0.01)
Z-score	-0.01***	-0.02***	-0.01	0.02***
	(0.00)	(0.00)	(0.01)	(0.00)
Observations	10,198	24,986	12,924	20,312
R-squared	0.47	0.44	0.23	0.30

Table 2.A5: **CDS trading and employee pay: Financial constraints.** This table presents the coefficients and standard errors obtained from the baseline regression. The coefficients of interest are $CDS\,Trading$ and the interaction term $CDS\,Trading \times WW\ index$ or $CDS\,Trading \times Small\ Size$. $WW\ index$ is the Whited and Wu (2006) financial constraint index. *Small Size* equals one if the firm size is in the lowest quartile. Industry and year fixed effect are included. Industry is defined by the first two digits of the SIC code. The standard errors presented in parentheses are robust to heteroskedasticity and clustered by firm level. The symbols ***,**, and * denote significance levels of 1%, 5%, and 10%, respectively.

Variables	(1) Average employee pay	(2) CEO Salary	(3) CEO Bonus	(4) CEO Equity pay
Panel A: Financial constraints (WW index)				
CDS Trading	0.51**	0.60***	0.17	0.55***
	(0.21)	(0.07)	(0.23)	(0.20)
CDS Trading × WW	1.04**	1.53***	0.14	1.04**
	(0.47)	(0.18)	(0.61)	(0.51)
WW	-1.70***	-1.79***	-3.94***	-2.84***
	(0.53)	(0.37)	(1.10)	(0.89)
Observations	5,925	12,878	6,820	11,001
R-squared	0.51	0.59	0.48	0.58
Panel B: Firm size				
CDS Trading	0.08**	0.07***	0.25***	0.44***
	(0.04)	(0.01)	(0.04)	(0.04)
CDS Trading × Small size	0.58***	0.01	0.33**	0.10*
	(0.15)	(0.04)	(0.13)	(0.11)
Small size	-0.23***	-0.30***	-0.63***	-0.94***
	(0.04)	(0.01)	(0.03)	(0.03)
Observations	12,143	29,024	15,227	23,573
R-squared	0.51	0.49	0.35	0.37

Chapter 3

Credit Default Swaps and Financial Contracting: Theory

3.1. Introduction

The introduction of credit default swaps (CDSs) and the explosive growth of their market in recent years had a significant impact on the debtor-creditor relationship. The past decade has seen the rapid development of research, both theoretical and empirical, on the costs and benefits of the CDS market motivated by CDS-related regulatory changes following the last financial crisis. However, little attention has been paid to how the presence and availability of CDSs might affect financial contracting in general.

The optimality of financial contracts is at the heart of corporate finance literature since the seminal work of Jensen and Meckling (1976). The literature has recognized its importance in understanding mechanisms which help to overcome various frictions between claim holders associated with outside financing. Contract incompleteness and lack of commitment of equity holders to repay a debt and/or implement policies that maximize firm value create agency conflicts between debt and equity. Any contract is incomplete because it is impossible to anticipate and specify all future states of the world (Coase, 1937). That might lead to an opportunistic behaviour by the party with the stronger bargaining position in states of the world not covered by the contract. Examples of this behaviour are strategic default, dilution of the value of existing debt claims, asset substitution, underinvestment and leverage ratchet effect in the form of resistance to debt reductions.

Our theoretical study is mainly motivated by recent empirical findings of Shan, Tang, and Winton (2019), who focus on the effect of the CDS market on design of corporate debt contracts with particular reference to loan contractual protection. The authors document less restrictive covenants and lower collateral requirements in newly issued loans of CDS-traded firms. They argue that these results can be explained by lenders' moral hazard in the presence of CDSs, which reduces lenders' incentive to monitor. However, this argument remains controversial. Creditor monitoring of borrowers goes beyond monitoring of loan terms, and it also represents an important task for bank regulatory compliance. Basel Committee on Banking Supervision has developed twenty-nine core principles for effective banking supervision, which are the de facto minimum standard for regulation and supervision of banks and banking systems (Core principles for effective banking supervision, BIS, 2019). In accordance with Basel Core Principles 15 - 18, banks are required to have a comprehensive credit risk management process, that includes policies and processes to identify, measure, evaluate, monitor, report and control or mitigate credit risk on a timely basis. In addition to these requirements, banks are required to maintain adequate provisions, reserves and capital levels. Timely monitoring of borrower financial condition underlies the assessment of an appropriate amount of loan loss reserves, which in turn affects lenders' Tier 1 regulatory capital (Guidance on credit risk and accounting for expected credit losses, BIS, 2015).[1] The requirement to comply with supervisory standards (e.g., comprehensive credit risk management, maintenance of adequate capital levels) remains unchanged for CDS-protected lenders. When a bank is not complying with regulations, the supervisor has power to impose a range of sanctions, revoke the bank's licence, etc.

Based on the findings of looser loan terms post inception of CDS trading, Shan, Tang, and Winton (2019) suggest that the access of creditors to the CDS market improves contracting efficiency by substituting loan contractual protection and reducing contracting costs. To the best of our knowledge, there is no theoretical study that analyses the effect of CDS introduction on financial contracting and establishes predictions for empirical analysis to test. In our study, motivated by Shan, Tang, and Winton (2019), we examine whether the introduction of CDS trading affects creditors' incentives to use traditional tools of financial contracting, such as financial (accounting-based) covenants, for protection of their interests in loan agreements.

[1] In US, Basel Core Principles are adopted, among others, in ASC 310/FAS 114, which requires banks to maintain a loan classification to assess credit risk and determine an appropriate amount of loan loss reserves. While the loan loss reserves should be timely adjusted for any increase in credit risk, due to its effect on earnings it also results in a decreased level of lenders' Tier 1 regulatory capital.

In theory, one instrument can change the incentive to use another instrument when it either can replace it as an adequate substitute, or when it can affect the work of another tool in the joint use. The substitution of one instrument for another is possible just when it is made to function like the original. In other words, we can expect that CDS trading can replace covenants in loan agreements, if it solves problems that are typically addressed by covenants.

Traditionally, debt holders include covenants in loan agreements as a way to reduce the costs of no-commitment by disciplining and determining the set of policies that shareholders are committing to. Specifically, the presence of covenants motivates shareholders to adjust their firm policies ex ante to minimise the likelihood of triggering a covenant violation, which might result in a costly renegotiation. In addition, covenants can be used ex post as a contractible signal of the need of renegotiation and allow to allocate control (decision) rights between contracting parties on a state-contingent manner. Whereas, the transfer of control rights to creditors allows to take remedial actions and discipline borrowers both outside and in financial distress (e.g., see Chava and Roberts, 2008; Gorton and Kahn, 2000). Consequently, the actions employed by creditors in response to a covenant violation allows to improve the value of violating firms through changes in their investment and financing behaviour (Nini, Smith, and Sufi, 2009). Overall, Gamba and Triantis (2014) show that while covenants affect corporate policies both ex ante and ex post, much of the effect occurs ex ante, away from the covenant violation point.

Bolton and Oehmke (2011) are the first to show theoretically that the emergence of the CDS market strengthened bargaining position of creditors and provided a new commitment device for borrowers to repay their obligations. Access to credit insurance makes renegotiation more difficult as creditors demand a higher payoff and impose hasher loan terms in debt renegotiation or, in a case of creditors' over-insurance, push borrowers into bankruptcy (as an "empty creditor") following the non-payment of debt.[2] Despite the discussed above commitment benefits of CDSs, it is not clear a priori how CDSs affect agency distortions in borrowers' investment and financing decisions. Intuitively, with CDSs self-interested equity holders should reflect in their decisions the lower possibility of future renegotiation in financial distress. On the one hand, the increased renegotiation frictions and the subsequent reduction of the occurrence of strategic default might reduce deviations from firm value maximising decisions.[3] On the other hand, the anticipation of forceful liquidation with no

[2]The problem of empty creditors was firstly introduced by Hu and Black (2008) based on the idea of separation of creditors' cash flow rights from their control rights.

[3]For instance, Pawlina (2010), drawing on the results of his theoretical model, suggests that the

chance to renegotiate the debt might increase the equity holders' incentive to engage in opportunistic behaviours, especially when the firm approaches financial distress.

Taking into account that both CDSs and covenants can improve contracting efficiency by increasing ex post shareholders' commitment, we theoretically examine if the presence of one instrument changes the incentives to hold the other. We construct a two-period model with a levered firm that optimally chooses investment in each period and decides whether to repay the debt or renegotiate it with the creditors at the end of the period. The model captures important features of real world contracts such as contract incompleteness and lack of commitment of equity holders. The latter leads to a possibility of strategic default, whereby even in a solvent state the shareholders threaten to default strategically and renegotiate to appropriate creditors' wealth. That also creates an incentive to underinvest at an earlier date given the anticipation that some benefits from investing in capital might be transferred to creditors under renegotiation. Overall, the model generates both underinvestment and strategic default. Using this baseline model, we examine the rationality for creditors to have either instrument or both. Specifically, we first measure how effective covenants and CDSs considered individually in protecting the debt from agency conflicts by reducing deviations from firm value maximizing investment decisions and shareholders' incentive to default strategically. Next, by allowing the two instruments together, we examine any changes in effectiveness of each instrument under the presence of the other.

The analysis of rationality for creditors to have either commitment mechanism shows that CDSs and covenants can serve the same purpose.[4] More specifically, both tools increase the protection of debt by reducing the occurrence of strategic default. Debt covenants, by imposing constraints on firm policies and moving endogenous investment closer to the one maximizing the firm value, lead to an increase in the firm continuation value and a reduction in the scope for renegotiation. As a result, the covenant-enhanced model generates a lower renegotiation threshold (i.e., the threshold such that equity holders are indifferent between repayment and renegotiation). The way CDS contracts affect strategic-debt service is different. In the presence of CDS trading, creditors are less concerned about liquidation costs due to their confidence in

debt overhang might be reduced by higher renegotiation frictions such as in public debt, for which disperse debt holding increases coordination costs and makes renegotiation prohibitively expensive (Rajan, 1992), and/or in legal systems with strong enforcement of creditors' rights (Favara, Schroth, and Valta, 2012).

[4]Throughout the thesis, we follow DeMarzo (2019) and use the term "commitment mechanism" to define any countervailing force against no-commitment. As widely used commitment mechanisms in practice, DeMarzo (2019) discusses collateral, seniority provisions, and restrictive covenants.

collecting an insurance payment following a credit event. Consequently, renegotiation frictions increase. Hence, the stricter the covenant, or the greater creditors' protection in the CDS market, the lower wealth transfer from debt to equity caused by future strategic debt service.

As for distortions of the optimal investment policy caused by lack of commitment, we find that covenants and CDSs are not equally effective at preventing them. Specifically, we provide an additional theoretical confirmation on covenants' ability to restore the shareholders' investment incentive reduced by debt overhang. The aim of avoiding technical default and large renegotiation costs reduce the occurrence of investment decisions that are highly costly to debt holders. The stricter financial covenants, the lower the deviation from the firm value optimizing investment policy. On the contrary, the effect of CDS contracts on investment-related agency distortions is ambiguous, and it can both alleviate or exacerbate the debt overhang problem.

The ambiguity of CDS effect is driven by two economic forces conditional on the renegotiation (liquidation) event. According to our model, the likelihood of CDS-protected creditors to turn into empty creditors, who always prefer to force the firm into bankruptcy even though renegotiation would be efficient, increases with the creditors' protection in the CDS market and decreases with firm financial stability. When the probability that creditors force a liquidation is low and debt renegotiation feasible, the introduction of CDSs allows to reduce underinvestment. In contrast, when the probability that creditors force a liquidation is high and debt renegotiation is ruled out, creditors' protection in the CDS market increases underinvestment. In other words, shareholders, fearing forceful liquidation caused by empty creditors and sharing the return of equity-financed investment with debt holders in default, will pass up valuable investment opportunities. As a result, borrowers that are most affected by the empty creditor problem are more likely to face adverse effects of CDS trading on their default risk, investment activity and firm value. The exacerbation of debt overhang problem is also consistent with the recent theoretical study of Wong and Yu (2018), who by introducing a Leland's (1994) type model with dynamic investment opportunities show that the CDS market increases debt overhang via the empty creditor channel.

Taken together, the current analysis does not support the inference offered in recent empirical study of Shan, Tang, and Winton (2019), which suggests that the covenant protection can be replaced by CDS trading. Rather, our findings demonstrate that debt covenants are a more universal tool for debt protection and so the reason of a negative correlation observed empirically between covenants and CDSs might be found elsewhere. That is consistent with a new paper-discussion by Demerjian (2019), which came to our attention while the thesis was being prepared for final submission. Similarly to our study, Demerjian (2019) raises a question of whether weakened loan provisions in CDS firms could be associated with an improved contracting efficiency and a substitution of loan contractual protection, as suggested in Shan, Tang, and Winton (2019). He discusses aspects why CDSs may or may not be a substitute for traditional tools of financial contracting. The paper emphasizes that CDS and covenants serve distinct purposes, with CDS addressing all credit risk and covenants addressing agency conflicts.[5] Given the complexity of the problem, Demerjian (2019) highlights the importance for future research to understand the full nature of risk that CDSs and covenants address. Because the reality might be more complex, and a negative correlation observed empirically between these instruments might be not due to the substitution effect. This thesis answers the questions raised by Demerjian (2019).

Next, considering the two commitment mechanisms at the same time, we show the lowest wealth transfer from debt to equity caused by future strategic debt service, and the reduction in the likelihood of inefficient liquidation caused by CDS-protected empty creditors. On the other hand, the presence of CDS trading can negatively affect covenant effectiveness at alleviating underinvestment. When the empty creditor issue is likely, covenants prove ineffective given underinvestment is still the equilibrium outcome. Such loss of covenant effectiveness provides an explanation to current empirical findings. First, it explains empirical findings of Chakraborty, Chava, and Ganduri (2015), who document no creditors' intervention in investment policies of CDS traded firms, including those with agency problems, following covenant violations. Thus, the loss of covenant effectiveness as a debt protection tool can be much broader, and also be related to its ex post disciplining effect on corporate policies following technical default. Next, our findings provide a new explanation for the empirically observed negative effect of the introduction of CDS contracts on covenant tightness in Shan, Tang, and Winton (2019). Covenants are costly because they constrain a firm's behavior. If they are not useful in addressing the debt overhang problem after the introduction of CDSs, then it makes sense for the firm and the lender to negotiate looser covenants at loan inception.

The remaining part of the chapter proceeds as follows. Section 3.2 summarizes

[5]Differently from Demerjian (2019), we also provide the model which is able to explain channels through which (and to what extent) CDS protection affects agency conflicts. We show that CDSs are not an adequate substitute for covenants owing to a possible exacerbation of agency conflicts by CDS trading.

the relevant literature and explains a conceptual link between CDSs and covenants. Section 3.3 details a baseline model with agency conflicts caused by shareholders' lack of commitment absent covenant restrictions and CDSs. Section 3.4 examines the effect of each commitment tool on the shareholder optimal policy individually by solving analytically a constrained second-best optimization problem. Section 3.5 examines the rationality for lenders to use covenants and CDSs together by measuring changes in effectiveness of each instrument under the presence of the other. Section 3.6 concludes the chapter.

3.2. Literature Review

A key feature of our model is the inability of firms to commit to debt repayment and firm value maximizing policies, which in turn results in creditor wealth expropriation. Despite decades of research, the commitment problem remains an important question in corporate finance literature. For instance, the recent theoretical study of DeMarzo (2019) has reframed the question of capital structure through demonstrating that the static predictions of standard trade-off theory do not apply (either disappear with complete contracts, or become irrelevant absent commitment) in a dynamic context, and equilibrium outcomes depend almost entirely on the commitment mechanisms (such as collateral, seniority provisions, restrictive covenants, regulatory constraints) available to firms. To examine the resulting magnitude of agency costs, we exclude any commitment mechanism (countervailing force) that aligns interests of shareholders and debt holders from the baseline model.

First, our model incorporates the debt-equity agency conflict associated with strategic default. Strategic debt-service was firstly introduced by Hart and Moore (1989, 1994), who showed that default might occur not just in a situation of insufficient cash flow ("liquidity default"), but also owing to equity holders' aspiration to distract cash to themselves. It means that even in the case when equity holders have sufficient cash to make contractual payments, there is the risk for debt holders that borrowers under-perform on servicing their obligations ("strategic default"). Such opportunistic behaviour is likely in states in which debt holders are less likely to initiate liquidation or bankruptcy. High bankruptcy costs and low continuation value in states in which the firm is insolvent make bankruptcy inefficient and create a scope for renegotiation. The equity holders' incentive to act strategically by forcing concessions in debt-service obligation from debt holders is based on the fact that firms are closer to financial distress and debt is risky. As emphasized by Mella-Barral and Perraudin (1997), when the debt becomes risky, equity holders are no longer the residual claimants on the firm's income stream because the debt value is close to the firm's liquidation value. The importance of the effect of strategic debt service on credit risk is highlighted, among others, by Garlappi and Yan (2011), who show its significant role in explaining the distress puzzle. The empirical literature also demonstrates the reflection of strategic default in credit spreads, equity beta and volatility (Davydenko and Strebulaev, 2007; Favara, Schroth, and Valta, 2012).

The emergence of the CDS market has provided a commitment device allowing to reduce the likelihood that shareholders may default for strategic, rather than solvency, reasons. The access to credit insurance makes creditors less concerned about liquidation costs due to their confidence in collecting an insurance payment from a protection seller following a credit event. As a result, strengthening bargaining power of creditors and their more aggressive behaviour over renegotiation reduces the incidence of strategic default (Bolton and Oehmke, 2011; Danis and Gamba, 2018; Kim, 2016). Despite the broad use of covenants by debt holders as a tool intended to reduce the costs of no-commitment, the current literature does not link it to the instruments allowing to mitigate strategic debt service. We fill this gap by building a model which enables to assess the channels through which (and to what extent) CDSs and covenants considered individually and in combination affect the likelihood of strategic default. Specifically, we follow Fan and Sundaresan (2000), Danis and Gamba (2018) and consider the strategic interaction between claim holders in two games. First, the firm strategically decides whether to repay the debt or renegotiate it with creditors at the repayment date. Second, at the moment of renegotiation, claim holders, seeking to extract some surplus (i.e., to get payoff above their outside options), play a Nash bargaining game. We use the equilibrium outcome of the game to derive the threshold such that shareholders are indifferent between repayment and renegotiation. That allows us to understand the mechanisms through which commitment devices affect the likelihood of strategic default.

Next, the model incorporates distortions of firm policies caused by lack of commitment. We do not try to capture all known types of agency costs associated with endogenous deviations from firm maximizing policies, and focus particularly on investment-related agency costs associated with outstanding debt, which can be renegotiated. The presence of risky debt and the lack of commitment to repay it naturally create an incentive to underinvest given the anticipation that some benefits from investing in capital might be transferred to the creditors under renegotiation.

The discussion on the relation between underinvestment and renegotiable debt can be found in Sundaresan and Wang (2007) and Pawlina (2010). Pawlina (2010) shows the possibility of debt renegotiation at the times of financial distress exacerbates Myers (1977) underinvestment problem upon the firm's expansion. Underinvestment caused by debt overhang is one of the central focus of the debt-equity agency literature.[6] Moyen (2007), analysing the effect of underinvestment in a dynamic stochastic framework, demonstrates that the magnitude of agency costs is large, and represents 2.61% (4.98%) of the firm value for long-term (short-term) debt. The relevance of underinvestment problem is supported not just theoretically, but also empirically (Hennessy, 2004).

We use the underinvestment baseline condition to measure how effective a protective debt covenant and a CDS contract per se and in combination can be in moving equity holders' investment policy closer to the firm value maximizing one. The literature indicates that covenants is a traditional welfare improving tool broadly included in loan agreements.[7] The main rationales for covenants can be classified according to the "conflict" and "control" views (Tirole, 2010). The first view assumes an ability of covenants to prevent equity holders from taking actions that might be privately optimal for them but would expropriate the lenders. Based on the "control" view, covenants enable to define a range of circumstances under which claim holders get the right to intervene in management. Consequently, the inclusion of covenants allows to limit debt-equity conflicts through reducing distortions on investment and financing decisions related to lack of commitment of shareholders. One of the first detailed evidence was provided by Smith and Warner (1979) who investigate mitigating agency problems by different types of covenants. This idea also has been confirmed by more recent theoretical studies such as Gârleanu and Zwiebel (2009), Gamba and Triantis (2014), Arnold and Westermann (2016), and Xiang (2019). Despite most of empirical studies concentrates mainly on creditors' intervention in corporate policies as a result of renegotiation following technical default (Chava and Roberts, 2008; Nini, Smith, and Sufi, 2009), Gamba and Triantis (2014) and Xiang (2019) provide the theoretical evidence that covenants alter corporate policies more generally and across many states, and not simply at points where covenants are violated. Another recent theoretical study of Gamba and Mao (2019) highlights the importance of the presence of renegotiation frictions for the ex ante positive effect of covenants on firm value.

[6] For instance, see Mello and Parsons (1992), Parrino and Weisbach (1999), Hennessy (2004), Moyen (2007), Sundaresan, Wang, and Yang (2015), and Chen and Manso (2016).

[7] Roberts and Sufi (2009) and Christensen, Nikolaev, and Wittenberg-Moerman (2016) provide good surveys on the literature on debt covenants that emphasizes its ability to enhance contracting efficiency.

They show that the renegotiation triggered by technical default improves the ex post firm value at an ex ante cost and may generate value losses similar to those absent shareholders' commitment. We complement these works by studying the effect of debt covenants on strategic debt service, and the relation between covenant tightness and mitigation of agency policy distortions.

In addition, our study contributes to the literature that examines effects of introducing CDSs on the debtor-creditor relationship.[8] In recent years, there has been many contributions in this area stimulated by the 2007/2008 financial crisis and the ensuing regulation. As it was emphasized earlier, Bolton and Oehmke (2011) show theoretically the positive and negative real effects of the introduction of CDSs on a borrower's debt. Another theoretical study of Danis and Gamba (2018) shows that while the introduction of CDSs has both positive and negative effects on firm value, the net effect is positive. The empty creditor hypothesis is supported by empirical studies of Subrahmanyam, Tang, and Wang (2014) and Danis (2016). Subrahmanyam, Tang, and Wang (2014) document that the introduction of CDSs leads to the growth in the probability of filing for bankruptcy, while Danis (2016) demonstrates that bondholders holding CDSs are less likely to engage in an out-of-court debt restructuring. Some positive effects of introducing CDSs were highlighted by Saretto and Tookes (2013), who report that the presence of CDSs makes credit supply to firms greater and allows firms to borrow at longer maturity. In addition, there are other theoretical studies by Morrison (2005) and Parlour and Winton (2013) which investigate the effect of CDS introduction on the debtor-creditor relationship in terms of banks' incentives to monitor. The above-mentioned authors show that the existence of the CDS market may lead to disintermediation and may reduce banks' incentives to monitor their borrowers. We complement these works by studying whether CDS contacts, used as a commitment device for borrowers to repay the debt, can also affect distortions to the value maximizing investment policy caused by lack of commitment. Our work is most closely related to the recent theoretical study of Wong and Yu (2018), who introduce a Leland's (1994) type model with dynamic investment opportunities and show that the CDS market drives debt overhang via the creditor channel. They show that debt overhang arises from the acceleration of the equity's bankruptcy time following the inception of CDS trading, that endogenously shifts the distribution of investment benefits towards the debt holders and forces the firm to forgo some positive net preset value (NPV) projects. Another related theoretical study is by Fostel and Geanakoplos (2016), who demonstrate underinvestment as a

[8]The current literature on CDSs is well summarized in a comprehensive survey of Augustin, Subrahmanyam, Tang, Wang, et al. (2014).

product of uncovered CDS positions. While the above cited works is focused mostly on the debt overhang as a result of the empty creditor channel, our model determines two possible mechanisms through which CDS trading can affect, alleviate or exacerbate, underinvestment.

Finally, our study sheds light on empirical works that study the effect of credit derivatives trading on financial contracting. To the best of our knowledge, we are the first who theoretically investigate whether the emergence of the CDS market changes creditors' incentive to use traditional tools of financial contracting, such as debt covenants. Our analysis is built on understanding whether CDS contracts can be considered as an adequate substitute for debt covenants, and whether the presence of CDS trading changes its effectiveness as a countervailing force against no-commitment. Thereby, our model provides a more complete theoretical foundation to current empirical research, that motivate their test hypotheses mainly by potential reduction in creditors' incentive to monitor and ignoring possible changes in effectiveness of covenants post CDS introduction. For instance findings of Shan, Tang, and Winton (2019), that demonstrate less restrictive covenants and lower collateral requirements in newly issued loans of CDS-traded firms, suggesting that loosening loan contractual protection by introducing CDS is beneficial to both claim holders in terms of reducing contracting costs. Another empirical study of Chakraborty, Chava, and Ganduri (2015) analyses how the presence of CDSs on debt affects the exercise of control rights by creditors after covenant violation. They document that CDS traded firms, including those with agency problems, do not decrease their investments after covenant violation in contrast to a significant reduction in investment of otherwise equivalent firms without CDSs (Chava and Roberts, 2008). Furthermore, cumulative abnormal returns of CDS traded firms in the post-violation period are not significantly different from zero and even negative in the long run in contrast to significant positive stock returns of otherwise equivalent non-CDS firms.[9]

3.3. A Baseline Model With Underinvestment

The baseline model features limited commitment, endogenous investment, and default decisions aimed at maximizing equity value, under the assumption that the level of debt cannot be changed. The baseline model excludes any countervailing force that

[9] Nini, Smith, and Sufi (2009) show that an improvement in firm value as a result of creditor intervention over renegotiation following covenant violation manifests itself in higher cumulative abnormal returns in the long run.

aligns interests of shareholders and debt holders. The lack of commitment of equity holders to repay debt results in strategic debt service. The inability of equity holders to commit to the value maximizing investment policy in the presence of risky renegotiable debt creates an incentive to underinvest. To single out an underinvestment agency issue, we benchmark the optimal equity-maximizing policy against the firm value maximizing one.

3.3.1. Economic and financial settings

There are three dates, $t = 0, 1, 2$. A firm makes real investment and default decisions to maximize the equity value. The firm's operating cash flow at t is $\pi(\theta_t, k_t) = \theta_t k_t^{\alpha}$, where $\alpha \in (0,1)$ to model decreasing returns to scale. The capital stock $k_t > 0$ depreciates at a constant rate $\delta = 1$.[10] The firm's productivity, $\theta_t > 0$, is an i.i.d. continuous-state random variable with cumulative probability distribution $\Psi(\theta_t)$ given compact support with density $\psi(\theta_t)$. We assume zero discount rate and do not consider taxes because they are inessential to our argument.

At dates $t = 0, 1$, after the productivity shock θ_t is realized and observed, the equity holders optimally invest, $I_t = k_{t+1} - k_t(1 - \delta) = k_{t+1}$, to get the capital stock for next period, k_{t+1}. At $t = 0$, contemporaneously with the investment decision, the firm issues a two-period debt contract in the amount of $d(\theta_0, k_0)$ with a contractual repayment b at $t = 2$. Equity holders and debt holders are risk neutral. If the operating cash flow plus the proceeds from issuing debt minus the investment is positive, $\pi(\theta_0, k_0) + d(\theta_0, k_0) \geq I_0$, the residual after funding investment is paid as dividend. Otherwise, the firm costlessly raises equity to finance the gap. At $t = 1$, no debt is issued, any difference between the current cash flow and the amount the firm invests at this date being adjusted trading in the equity market.

At date $t = 2$, when the contractual repayment takes place, given the previously installed capital stock k_2 and the observed shock θ_2, the firm decides whether to repay the debt b in full or to default strategically and renegotiate the debt by paying $b_r < b$. The debt payment in renegotiation, b_r, is optimally derived later. Thus, given equity holders' lack of commitment and their aspiration to distract cash flow to themselves, even in a solvent state the shareholders may decide to default strategically and renegotiate the debt with the creditors. Such opportunistic behavior might take

[10] The assumption of fully depreciation is not a necessary assumption for our results, but it greatly simplifies the analytical expressions.

place in states in which the debt holders are less likely to initiate liquidation or bankruptcy. That, as a result, creates scope for renegotiation.

The timeline of the model is summarized in Figure 3.1. The baseline model in absent any covenant restrictions and CDSs (i.e., creditors' hedge ratio in the CDS market is $h = 0$) is unconstrained.

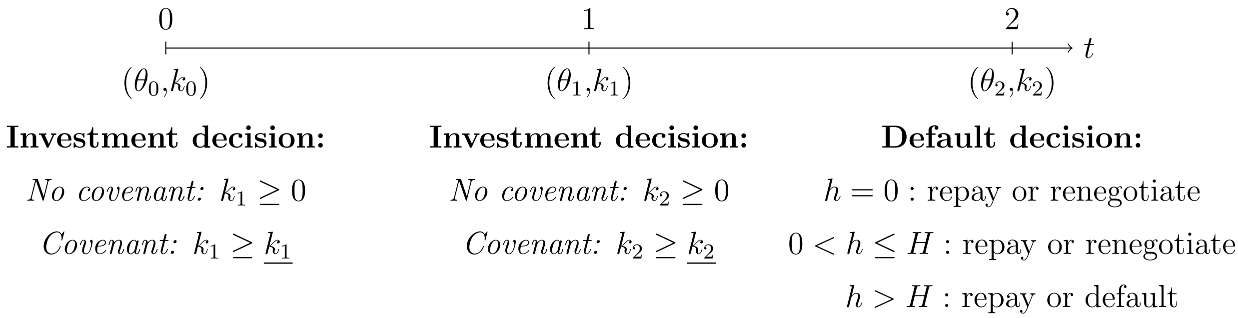


Figure 3.1: Timeline of the model

3.3.2. Firm value maximizing policy

As a benchmark for the case with lack of commitment, we first examine the firm value maximization, where at $t = 0, 1$ the firm selects an investment policy aimed at maximizing total firm value, given constant debt. The model is solved by backward induction.

At $t = 2$, the firm value is

$$F(\theta_2, k_2) = \theta_2 k_2^\alpha.$$

At $t = 1$, the firm chooses the first best investment policy in order to

$$F(\theta_1, k_1) = \max_{k_2 \geq 0} \theta_1 k_1^\alpha - k_2 + \mathbb{E}_1[F(\theta_2, k_2)], \tag{3.1}$$

where $\mathbb{E}_1[F(\theta_2, k_2)] = \int \theta_2 k_2^\alpha \, \psi(\theta_2) d\theta_2$ is the continuation value of the firm at $t = 1$.

Taking into account the optimal decision at $t = 1$, the value of the firm at $t = 0$ is

$$F(\theta_0, k_0) = \max_{k_1 \geq 0} \theta_0 k_0^\alpha - k_1 + \mathbb{E}_0[F(\theta_1, k_1)]. \tag{3.2}$$

The following proposition summarizes the optimal investment policy at $t = 0, 1$ based on equations (3.1) and (3.2).

Proposition 3.1 (Optimal investment policy). *The optimal investment policy maximizing the total firm value at date t is k^F_{t+1}, which satisfies condition*

$$1 = \mathbb{E}_t \left[\frac{\alpha \theta_{t+1}}{(k^F_{t+1})^{1-\alpha}} \right], \tag{3.3}$$

where k^F_2 is independent of k_1 given the investment decision at $t = 1$ is unconstrained, i.e. there are non-negativity constraints and no costs on equity issuance.

Proof. See Appendix. □

3.3.3. Equity value maximizing policy

We now turn to the optimal policy from the equity's perspective with lack of commitment i.e. when shareholders do not commit to firm value maximization in future decisions.

At $t = 2$, equity holders optimally choose whether to repay the debt b in full, or default strategically and renegotiate the debt by paying $b_r < b$, or file for bankruptcy. Where b_r is the debt payment derived as the equilibrium outcome of a Nash bargaining game between the equity holders and the debt holders in renegotiation based on their bargaining power, $q \in [0,1]$ for the debt holders and $1 - q$ for the equity holders,

$$b_r(\theta_2,k_2) = \arg \max_{p \in \mathcal{A}(\theta_2,k_2)} \left[\theta_2 k_2^\alpha - p\right]^{1-q} \cdot \left[p - \ell \theta_2 k_2^\alpha\right]^q,$$

in which the set of feasible decisions $\mathcal{A}(\theta_2,k_2)$ is such that $\ell\theta_2 k_2^\alpha \le p \le \theta_2 k_2^\alpha$, where $\ell\theta_2 k_2^\alpha$ is the liquidation value of assets reduced by proportional bankruptcy costs $1 - \ell \in (0,1)$. The constraint defining the feasible set shows that both parties are seeking to extract some surplus from the renegotiation to make sure that their payoff is above the outside option. The creditors expect that the renegotiated debt payment is not below the liquidation value of assets, $b_r \ge \ell\theta_2 k_2^\alpha$, and the equity holders want to make a non-negative payoff, $\theta_2 k_2^\alpha - b_r \ge 0$.

Consequently, the Nash solution to the renegotiation game is $b_r(\theta_2,k_2) = \lambda\theta_2 k_2^\alpha$, where $\lambda = q + \ell(1 - q)$, $\lambda \in (0,1]$ under the initial parameter assumptions. Next, we derive the threshold θ_P such that equity holders are indifferent between repayment and renegotiation, that is $b = b_r(\theta_2, k_2)$, which gives[11]

$$\theta_P(k_2, b) = \frac{b}{k_2^\alpha} \cdot \frac{1}{\lambda} > 0, \tag{3.4}$$

where the shareholders optimally decide to repay the debt in full if $\theta_2 \geq \theta_P(k_2, b)$ and to renegotiate if $\theta_2 < \theta_P(k_2, b)$. The decision to default strategically is affected by the level of capital and debt, i.e. the firm leverage at the moment of making the decision.

Proposition 3.2. *The higher the leverage, the higher the threshold θ_P, which makes strategic default more likely.*

Proof. Straightforward, by taking partial derivative of $\theta_P(k_2, b)$ with respect to k_2 and b. □

Given the optimal default decision, the equity holders' payoff at $t = 2$ is

$$E(\theta_2,k_2, b) = \mathbb{1}_{\{\theta_2<\theta_P\}} \left(\theta_2 k_2^\alpha - b_r(\theta_2,k_2)\right) + \mathbb{1}_{\{\theta_2\geq\theta_P\}} \left(\theta_2 k_2^\alpha - b\right),$$

where $\mathbb{1}_{\{\theta_2<\theta_P\}}$ is the strategic default indicator. The debt holders then receive b when $\theta_2 \geq \theta_P$ and b_r when $\theta_2 < \theta_P$:

$$D(\theta_2,k_2, b) = \mathbb{1}_{\{\theta_2<\theta_P\}} b_r(\theta_2,k_2) + \mathbb{1}_{\{\theta_2\geq\theta_P\}} b.$$

The total firm value is the sum of the value of debt and equity

$$F(\theta_2, k_2) = E(\theta_2,k_2, b) + D(\theta_2,k_2, b) = \theta_2 k_2^\alpha.$$

At $t = 1$, given the realized productivity shock θ_1 and the current capital k_1, the equity holders decide the optimal k_2:

$$E(\theta_1, k_1, b) = \max_{k_2\geq 0} \theta_1 k_1^\alpha - k_2 + \mathbb{E}_1[E(\theta_2, k_2, b)], \tag{3.5}$$

where given the optimal default policy derived in (3.4), according to which the rene-

[11] The decision to file for bankruptcy is never optimal for the equity holder and can be ruled out from the analysis. The renegotiation decision always dominates the liquidation given the constraint $\theta_2 k_2^\alpha - b_r(\theta_2, k_2) \geq 0$ (i.e. $\theta_2 k_2^\alpha \cdot (1 - \lambda) \geq 0$) and the negative value of the liquidation threshold, $\theta_2 < \theta_L < 0$.

gotiation is optimal for $0 < \theta_2 < \theta_P(k_2)$ and repayment is optimal for $\theta_2 \geq \theta_P(k_2)$,

$$\mathbb{E}_1[E(\theta_2, k_2, b)] = \int_0^{\theta_P(k_2)} [\theta_2 k_2^\alpha - b_r(\theta_2,k_2)]\, \psi(\theta_2) d\theta_2 + \int_{\theta_P(k_2)}^{\infty} [\theta_2 k_2^\alpha - b]\, \psi(\theta_2) d\theta_2.$$

Given the optimal default and investment policy, k_2^E, derived later based on equation (3.5), the debt value at $t = 1$ is

$$D(\theta_1, k_1, b) = \mathbb{E}_1[D(\theta_2, k_2^E, b)] = \int_0^{\theta_P(k_2^E)} b_r(\theta_2, k_2^E)\, \psi(\theta_2) d\theta_2 + b(1 - \Psi(\theta_P)).$$

The total firm value at $t = 1$ is then

$$F(\theta_1, k_1) = E(\theta_1,k_1, b) + D(\theta_1,k_1, b) = \theta_1 k_1^\alpha - k_2^E + \mathbb{E}_1[F(\theta_2, k_2^E)].$$

At $t = 0$, given an initial endowment, the equity holders maximize their value by making an optimal investment decision:

$$E(\theta_0, k_0, b) = \max_{k_1 \geq 0} \theta_0 k_0^\alpha - k_1 + \mathbb{E}_0[E(\theta_1, k_1, b)]. \tag{3.6}$$

In consequence of optimal investment policy, k_1^E, derived later based on equation (3.6), the debt value at $t = 0$ is

$$\begin{aligned} D(\theta_0, k_0, b) &= \mathbb{E}_0[D(\theta_1, k_1^E, b)] \\ &= \int \left[\int_0^{\theta_P(k_2^E)} b_r(\theta_2, k_2^E)\, \psi(\theta_2) d\theta_2 + b(1 - \Psi(\theta_P)) \right] \psi(\theta_1) d\theta_1. \end{aligned}$$

The total firm value is then

$$F(\theta_0, k_0) = E(\theta_0,k_0, b) + D(\theta_0,k_0, b) = \theta_0 k_0^\alpha - k_1^E + \mathbb{E}_0[F(\theta_1, k_1^E)].$$

The following proposition summarizes the optimal investment policy at $t = 0, 1$ based on equations (3.5) and (3.6).

Proposition 3.3 (**Optimal investment policy without commitment**). *For an equity value maximizing firm with outstanding debt b and costless external equity, at*

$t = 1$, *the optimal investment policy is* k_2^E, *which solves condition*

$$1 = \mathbb{E}_1 \left[\mathbb{1}_{\{\theta_2 < \theta_P\}} \left(\frac{\alpha \theta_2}{(k_2^E)^{1-\alpha}} \right) \cdot (1-\lambda) + \mathbb{1}_{\{\theta_2 \geq \theta_P\}} \left(\frac{\alpha \theta_2}{(k_2^E)^{1-\alpha}} \right) \right]. \tag{3.7}$$

At $t = 0$, *the optimal investment policy is* k_1^E, *which solves*

$$1 = \mathbb{E}_0 \left[\frac{\alpha \theta_1}{(k_1^E)^{1-\alpha}} \right]. \tag{3.8}$$

Proof. See Appendix. □

3.3.4. Agency conflicts

The equity maximizing and the firm maximizing policies may differ form each other because debt financing under limited liability and contract incompleteness might create an incentive for the equity holders to act in their own interest and transfer wealth from the creditors to themselves. This conflict of interest leads in some states the shareholders to take suboptimal corporate decisions.

First, the comparison of two programs shows that the lack of commitment of equity holders leads to a possibility of strategic default in the equity maximizing policy, whereby even in a solvent state, $\theta_2 < \theta_P$, the shareholders decide to default strategically and renegotiate to appropriate creditors' wealth.

Next, we measure the investment agency distortions by comparing the optimal policies k_t^E and k_t^F for $t = 0, 1$ given by Propositions 3.1 and 3.3. The comparison indicates that these two programs differ in the expected marginal benefits of capital at $t = 1$. Under firm value maximization, the firm has an expected claim on the assets in all states at the end of the period, whereas under equity maximization if the state θ_2 is below the renegotiation threshold θ_P, there is a reduced value of the claim on the assets in renegotiation. Consequently, the equity holders may prefer to underinvest at $t = 1$ anticipating that some benefits from investing in capital might be transferred to the creditors under renegotiation. This produces underinvestment due to debt overhang associated with outstanding renegotiable debt.[12] The above findings are formalized in the following proposition.

[12]Note, the optimal investment policy at $t = 0$ is not affected by introducing any commitment tool given the model design, costless equity financing and independence of current investment decisions on following ones.

Proposition 3.4 (**Agency conflicts**). *For a firm with outstanding debt b and costless external equity:*

1. *The lack of equity holders' commitment increases the likelihood of strategic default at* $t = 2$*, when* $0 < \theta_2 < \theta_P$.
2. *The possibility of strategic default creates an incentive to underinvest. At* $t = 1$*:* $k_2^E < k_2^F$.

Proof. See Appendix. □

Taken together, the possibility of strategic debt service and the deviation from the efficient investment reduce the firm value and allow the shareholders to take advantage of unprotected lenders. In the following sections, we use the results of Proposition 3.4 as the baseline condition to assess how effective debt covenants and CDSs considered individually and together can be as countervailing forces against no-commitment. That allows us to understand whether the instruments can be used as substitutes or complements to each other.

3.4. Constrained Equity Maximization

In this section, we analyse the rationality of debt covenants and CDSs as commitment mechanisms considered individually to address underinvestment and strategic debt service given constraints instruments create to the equity value maximization program.

We examine the potential interaction between these tools by investigating the ability of either tool to solve the problem that is naturally addressed by the other instrument. In other words, in addition to the ability of covenants to reduce underinvestment, we also check if they can reduce the incentive to default strategically. Similarly, for CDSs, which are aimed at reducing strategic default, we also analyse their ability to address underinvestment. The above analysis allows us to understand whether one instrument is enough for creditors to reduce the agency issues, or there need to be both.

3.4.1. Debt covenants

In this section, we examine the effect of introducing a covenant to the debt contract, which places a constraint on the shareholders' optimal policy. Among a variety of debt covenants commonly used in practice, we focus our attention on financial (accounting-based) covenants as a well-defined and measurable aspect of financial contracting. Billett, King, and Mauer (2007) and Bradley and Roberts (2015) document that the inclusion of covenants based on accounting metrics in loan agreements is common for both private and public loans. We follow Gamba and Triantis (2014) and concentrate on a "Maximum Debt to EBITDA" covenant, which is one of the most prevalent covenants in the sample of private loans according to the empirical literature (e.g., see Chava and Roberts, 2008).

The covenant on a maximum Debt/EBITDA ratio, the calculation of which requires variables from both the balance sheet and the income statement, is related to the ability of a firm to service the debt. Furthermore, it combines the features of several covenants intended for different purposes such as imposing limitations on further indebtedness (like leverage and interest coverage restrictions), restricting asset stripping and asset substitution.[13] Gamba and Triantis (2014) provide evidence that owing to the compounding effects of distortions of different firm policies, the covenants that directly target distortions on the debt policy also indirectly affect and reduce distortions of investment policy, and vice versa.

We modify the baseline model by assuming that a "Maximum Debt to EBITDA" covenant, with a determined exogenously threshold value c^*, is added to the debt indenture at the loan inception. The covenant requires the current level of Debt/EBITDA ratio, $c(\theta_t,k_t,b)$, be below the specified covenant threshold,

$$c(\theta_t,k_t,b) = \frac{b}{\theta_t k_t^{\alpha}} \leq c^*. \tag{3.9}$$

and the covenant is violated when it is above the threshold c^*.

While most of the recent empirical studies (e.g., Chava and Roberts, 2008; Nini, Smith, and Sufi, 2009) concentrates mainly on the ex post effects of debt covenants, i.e. on the policy changes as a result of transfer of control rights from equity hold-

[13]There is a big variety of financial covenants indented to protect debt holders against known and unknown risks. Some of them are focused solely on balance sheet measures (e.g., maximum leverage, minimum net worth, minimum current ratio) or income statement measures (e.g., minimum EBITDA, minimum interest coverage).

ers to debt holders when covenants are violated, our model incorporates the ex ante effects of covenants. That is in line with the findings of Gamba and Triantis (2014) and Xiang (2019), who demonstrate that much of the effect of covenant restrictions on corporate policies occurs away from the violation point since shareholders make decisions that reduce the likelihood of triggering a violation. In other words, to avoid technical default and high potential renegotiation costs, shareholders may make investment and/or financing decisions ensuring the covenant compliance. Consequently, we assume that if the firm does well, it will be effectively unconstrained in making decisions. If the firm starts doing poorly, it becomes more constrained the closer the Debt/EBITDA ratio to the specified threshold c^*.

In the interest of realism, we assume that in order to avoid violation of the covenant shareholders can adjust both debt and investment policy, which are two components of the Debt/EBITDA ratio. Specifically, shareholders can reduce the debt b by the amount $f \in [0,b]$, chosen by the borrower freely.[14] Given the debt after repayment $b - f$ and the expected productivity $\bar{\theta}_{t+1}$ for next period, the equity holders make investment decision k_{t+1}, which cannot be below the minimum level $\underline{k_{t+1}}$ ensuring the covenant compliance in (3.9):

$$\underline{k_{t+1}}(\bar{\theta}_{t+1}, b, f, c^*) = \left(\frac{b - f}{c^* \bar{\theta}_{t+1}}\right)^{1/\alpha} > 0. \tag{3.10}$$

Proposition 3.5 indicates that the covenant imposes a greater constraint on optimal investment policy, i.e. it results in a higher minimum level of investment $\underline{k_{t+1}}$, the greater the debt $b - f$, the lower the expected productivity $\bar{\theta}$ and the tighter (stricter) the covenant threshold c^*.[15]

Proposition 3.5 (**Covenant constraint on investment policy**). *The constraint on shareholders' optimal investment policy is an increasing function of* b*, and a decreasing function of* f*,* $\bar{\theta}_{t+1}$ *and* c^**.*

Proof. Straightforward, by taking partial derivative of $\underline{k_{t+1}}$ with respect to b, f, $\bar{\theta}_{t+1}$ and c^*. $\square$

[14] The anticipation payment f is represented by an arbitrary value to keep the original logic of the baseline model, which focuses on the endogenous investment decisions only.

[15] An accounting-based covenant represented by a maximum (minimum) financial ratio is tighter when the covenant threshold is lower (greater). For instance, in our case for the "Maximum Debt to EBITDA" covenant, the lower c^*, the stricter the covenant and the higher the probability of violation.

As a result, the equity holders' maximization problem is changed to reflect the constraint on investment policy (see Figure 3.1 with the covenant restriction). To differentiate from the unconstrained equity maximization in Section 3.3.3, we use an upper bar to denote the updated value of variables in the presence of the debt covenant. At $t = 1$, the equity value is then

$$\bar{E}(\theta_1, k_1, b) = \max_{k_2 \geq \underline{k}_2} \theta_1 k_1^\alpha - k_2 - f + \mathbb{E}_1[\bar{E}(\theta_2, k_2, b - f)], \tag{3.11}$$

where

$$\begin{aligned} \mathbb{E}_1[\bar{E}(\theta_2, k_2, b - f)] = \int_0^{\bar{\theta}_P(k_2,b,f)} & (\theta_2 k_2^\alpha - b_r)\ \psi(\theta_2) d\theta_2 \\ & + \int_{\bar{\theta}_P(k_2,b,f)}^{\infty} (\theta_2 k_2^\alpha - (b - f))\ \psi(\theta_2) d\theta_2. \end{aligned}$$

The renegotiated debt level, $b_r(\theta_2,k_2)$, in the above equation is the same as in Section 3.3.3. That can be explained by the fact that it is independent on the face value of debt and determined by the outside options of claim holders in the renegotiation game. On the contrary, the renegotiation threshold, $\bar{\theta}_P(k_2,b,f)$, is changed according to the after-repayment debt, $b - f$,

$$\bar{\theta}_P(k_2, b - f) = \frac{b - f}{k_2^\alpha} \cdot \frac{1}{\lambda}. \tag{3.12}$$

We summarize the optimal investment policy at $t = 1$ in the following proposition, which demonstrates the debt covenant's ability to alleviate investment distortions at $t = 1$ by moving the investment policy closer to the one that maximizes firm value, and allowing to reduce the expropriation of creditors' wealth due to debt overhang.

Proposition 3.6 (**Optimal investment policy with covenant**). *For a firm with outstanding debt and costless external equity, the investment policy maximizing the equity value at $t = 1$ under the constraint aimed to maintain the expected Debt/EBITDA ratio at the required level c^* is k_2^C, which solves:*

$$1 = \mu + \mathbb{E}_1 \left[\mathbb{1}_{\{\theta_2 < \bar{\theta}_P(k_2,b,f)\}} \left(\frac{\alpha\theta_2}{(k_2^C)^{1-\alpha}} \right) \cdot (1 - \lambda) + \mathbb{1}_{\{\theta_2 \geq \bar{\theta}_P(k_2,b,f)\}} \left(\frac{\alpha\theta_2}{(k_2^C)^{1-\alpha}} \right) \right], \tag{3.13}$$

where $\mu \geq 0$, a Lagrange multiplier of the inequality constraints in (3.11), and $\bar{\theta}_P(k_2,b,f) \leq \theta_P(k_2,b)$ imply

$$k_2^E \leq k_2^C \leq k_2^F, \quad \text{for } f = 0,$$
$$k_2^E < k_2^C \leq k_2^F, \quad \text{for } f > 0.$$

Proof. See Appendix. □

At $t = 0$, the optimal investment decision is not affected by introducing the covenant given that the covenant threshold c^* is determined at the loan inception, when creditors are aware of the shareholders' investment decision on k_1 and the expected productivity $\bar{\theta}_1$. As a result, the capital level k_1 is effectively unbounded.

Interestingly, we find that in addition to the debt covenant's ability to alleviate underinvestment, it is also effective in reducing the likelihood of strategic debt service. By imposing a constraint on firm policies and moving investment closer to the one maximizing the firm value, the covenant allows to increase the firm continuation value, which is associated with a lower renegotiation threshold compared to the unconstrained level, $\bar{\theta}_P \leq \theta_P$.

Proposition 3.7 (**Covenant and strategic default**). *The constraints on the firm's policies imposed by the presence of debt covenant allow to reduce the shareholders' incentive to default strategically.*

Proof. Under the constraints on shareholders' investment policy and/or forcing leverage reduction, the renegotiation threshold becomes lower than the unconstrained one, $\theta_P(k_2^C,b,f) \leq \theta_P(k_2^E,b)$, given $k_2^C \geq k_2^E$ and $b - f \leq b$. The higher k_2 (or the lower b), the lower the threshold θ_P and the lower the probability of strategic default (see Proposition 3.2). □

3.4.2. Credit default swaps

Instead of having a covenant added to the loan indenture, we assume that at $t = 0$ the creditors purchase CDSs from a dealer to get protection against the borrower's default on the debt at $t = 2$. A CDS contract covers the debt exposure by a fraction h, chosen by the debt holder, where $h \in (0,1]$.[16] We assume that both the protection

[16] We do not model the creditors' optimal hedging policy for simplicity and tractability of the model. However, endogenizing h should not affect the main model's predictions, summarized in Proposition 3.10. Even in the absence of creditors' over-insurance (i.e., even for the moderate level of credit protection h), a state when CDS-protected lenders might turn into empty creditors would still exist for the lower realization of a parameter $H(\theta_2, k_2, b, \ell)$. The weaker firms' fundamentals, the more attractive bankruptcy option to lenders even in the absence of creditors' over-insurance in

seller (dealer) and the protection buyer (creditor) are risk neutral, and that CDS contracts are priced fairly because both parties have full information.

In the spirit of Bolton and Oehmke (2011), we consider the most common clause whereby bankruptcy is the credit event triggering an insurance payment by the protection seller to the creditors. Therefore, out-of-court debt restructuring is not a credit event and does not trigger a CDS payment. Similarly to Danis and Gamba (2018), the lenders' payoff $\Pi(\theta_2,k_2,b,h)$ in case of a credit event is

$$\Pi(\theta_2,k_2,b,h) = hb + (1-h)\ell\theta_2 k_2^{\alpha}, \tag{3.14}$$

where hb is the payment from the CDS seller and $(1-h)\ell\theta_2 k_2^{\alpha}$ is net of the payment to the CDS seller with ℓ being the liquidation price. The debt holders' payoff, the price of credit protection in the CDS market, and the resulted debt value are derived in Appendix.

To differentiate from the unconstrained equity maximization in Section 3.3.3, we use a hat to denote the updated value of variables in the presence of CDS trading. At $t = 2$, the equity holders optimally choose whether to repay the debt b in full or to default strategically and renegotiate the debt by paying $\hat{b}_r$, where $\hat{b}_r$ is the solution of the renegotiation game between the shareholders and the debt holders given a feasible region $\mathcal{A}(\theta_2,k_2,h)$. Similarly to the unconstrained optimization problem, $\mathcal{A}(\theta_2,k_2,h)$ is defined in a way that both parties of the renegotiation game are seeking to extract some surplus from the renegotiation to make sure that their payoff is above the outside option. The difference arises from the expectation of CDS-protected creditors to get a renegotiated debt payment not lower than the compensation made by the protection seller, $\hat{b}_r \geq \Pi(\theta_2,k_2,b,h)$. In other words, the debt holder will engage in renegotiation just when he expects a higher payoff from renegotiation than he can get from the CDS dealer.

Consequently, the Nash solution to the renegotiation game is

$$\begin{aligned}\hat{b}_r(\theta_2,k_2,b,h) &= \arg \max_{p\in\mathcal{A}(\theta_2,k_2,h)} \left[\theta_2 k_2^{\alpha} - p\right]^{1-q} \cdot \left[p - \Pi(\theta_2,k_2,b,h)\right]^{q} \\ &= \Pi(\theta_2,k_2,b,h) + q\left[\theta_2 k_2^{\alpha} - \Pi(\theta_2,k_2,b,h)\right] \\ &= hb\,(1-q) + \theta_2 k_2^{\alpha} \cdot \lambda(h),\end{aligned} \tag{3.15}$$

the CDS market. Furthermore, the findings of Wong and Yu (2018) of the amplified debt overhang post-CDS introduction based on a continuous-time model with endogenous CDS positions do not contradict our results.

where $\lambda(h) = q + (1-h)\ell(1-q)$.

The renegotiation payoff, $\hat{b}_r$, is increasing in k_2 and h. The higher the hedge ratio h, the higher the renegotiation payoff required to convince the creditor to renegotiate the debt.

From equation (3.15), renegotiation is possible when the feasible region of the bargaining problem is not empty. Otherwise, if $\Pi(\theta_2,k_2,b,h) > \theta_2 k_2^\alpha$, or equivalently, if

$$h > H(\theta_2, k_2, b, \ell) = \frac{\theta_2 k_2^\alpha \cdot (1-\ell)}{b - \ell\theta_2 k_2^\alpha}, \tag{3.16}$$

renegotiation is never initiated. The economic intuition of the threshold H is that debt holders are not interested in debt renegotiation when their credit protection from CDSs is above the ratio of the loss in firm value over liquidation to the value of debt not covered by the firm's liquidation value of assets. The greater the part of debt, that is uncovered, the higher the likelihood of the firm being forced into bankruptcy.

The likelihood of CDS-protected creditors to turn into empty creditors, who prefer to force the firm into bankruptcy, depends on two parameters: the hedge ratio h and the threshold $H(\theta_2, k_2, b, \ell)$ based on firm characteristics (see Proposition 3.8). The empty creditor threat is higher, the greater h and the lower H. Through the impact on the threshold H, the shareholders' investment decision at $t = 1$ makes renegotiation more or less likely. Firms with higher leverage, lower productivity and higher liquidation costs are more likely to be pushed into bankruptcy by creditors holding CDSs. That explains the empirical findings by Subrahmanyam, Tang, and Wang (2014), who show that distressed firms are more likely to file for bankruptcy if they are linked to CDS trading.

Proposition 3.8 (**Likelihood of renegotiation/liquidation**). *(1) The higher h, the greater the empty creditor threat. (2) The lower k_2 (or the lower θ_2 and ℓ, or the higher b), the lower H, which makes the firm more vulnerable to the empty creditor threat.*

Proof. Straightforward from (3.16), by taking partial derivatives with respect to k_2, θ_2, ℓ and b. □

The increase in renegotiation frictions following the introduction of CDS trading on a borrower's debt results in a change of the equity optimization problem, which is also summarized in Figure 3.1 for $h > 0$. Consequently, when the shareholders decide whether to repay the debt or to default strategically, the payoff in a default state depends on the hedge ratio h and the value of H. If the hedge ratio is below or equal to H, the payoff to equity equals the renegotiation surplus, $\theta_2 k_2^\alpha - \hat{b}_r$. If the hedge ratio is above H, the creditors force the firm into bankruptcy and the owners' payoff is zero. To summarize, the payoff to equity at $t = 2$ is

$$\hat{E}(\theta_2, k_2, b, h) = \begin{cases} \max\{\theta_2 k_2^\alpha - b,\ \theta_2 k_2^\alpha - \hat{b}_r\}, & \text{if } h \leq H \\ \max\{\theta_2 k_2^\alpha - b,\ 0\}, & \text{if } h > H. \end{cases} \tag{3.17}$$

From equation (3.17), in states in which renegotiation is feasible, $h \leq H$, we update the renegotiation threshold $\hat{\theta}_{P1}$ such that equity holders are indifferent between repayment and renegotiation, that is $b = \hat{b}_r(\theta_2, k_2, b, h)$, which gives

$$\hat{\theta}_{P1}(k_2, b, h) = \frac{b(1 - h(1-q))}{k_2^\alpha} \cdot \frac{1}{\lambda(h)}, \tag{3.18}$$

according to which the shareholders optimally decide to repay the debt in full when $\theta_2 \geq \hat{\theta}_{P1}$ and renegotiate when $\theta_2 < \hat{\theta}_{P1}$.

Additionally, the presence of CDS trading produces a default threshold $\hat{\theta}_{P2}$ in states when renegotiation is never achievable, $h > H$. According to this threshold, the firm always repays the debt in a solvent state, $\theta_2 k_2^\alpha \geq b$, and it is forced into bankruptcy when the firm's cash flow is insufficient to cover the contractual payment b. Thereby, the default threshold is

$$\hat{\theta}_{P2}(k_2, b) = \frac{b}{k_2^\alpha}, \tag{3.19}$$

according to which the debt is repaid in full when $\theta_2 \geq \hat{\theta}_{P2}$ and the firm is liquidated when $\theta_2 < \hat{\theta}_{P2}$.

The comparison of the derived above thresholds with the unconstrained level, $\hat{\theta}_{P1} \leq \theta_P$ and $\hat{\theta}_{P2} \leq \theta_P$, confirms the findings of previous studies emphasizing the ability of CDSs to reduce the incidence of strategic debt service at the costs of increasing the likelihood of ex post inefficient liquidation.

Proposition 3.9 (**CDS and strategic default**). *CDS reduces the occurrence of strategic default at $t = 2$ by decreasing the renegotiation threshold compared to the unconstrained case, $\hat{\theta}_{P1} \leq \theta_P$ and $\hat{\theta}_{P2} \leq \theta_P$.*

1. *For $h \leq H$, when renegotiation is feasible, the default threshold $\hat{\theta}_{P1}$ is decreasing in k_2 and h. The higher k_2 (or the higher hedge ratio h), the lower the probability*

of strategic default.

2. *For $h > H$, when renegotiation is ruled out, CDS reduces the incidence of strategic default at the costs of the increased likelihood of inefficient liquidation ex post.*

Proof. See Appendix. □

At $t = 1$, the equity holders make only a decision on the capital level for next period, k_2. Then, the equity value is

$$\hat{E}(\theta_1, k_1, b, h) = \max_{k_2 \geq 0} \theta_1 k_1^{\alpha} - k_2 + \mathbb{E}_1[\hat{E}(\theta_2, k_2, b, h)]. \tag{3.20}$$

In the following proposition, we summarize the optimal investment policy in the presence of CDS trading at $t = 1$ based on equation (3.20) and compare it to the results of the unconstrained equity maximization.

Proposition 3.10 (Optimal investment policy with CDS). *For a firm with outstanding debt and costless external equity, the investment policy maximizing the equity value at $t = 1$ is k_2^S, which solves*

$$\begin{aligned} 1 = {} & \mathbb{E}_1\left[\mathbb{1}_{\{h \leq H(\theta_2, k_2^S)\}}\left[\mathbb{1}_{\{\theta_2 < \hat{\theta}_{P1}\}}\left(\frac{\alpha\theta_2}{(k_2^S)^{1-\alpha}}\right)\cdot(1-\lambda(h))\right]\right] \\ & + \mathbb{E}_1\left[\mathbb{1}_{\{h \leq H(\theta_2, k_2^S)\}}\left[\mathbb{1}_{\{\theta_2 \geq \hat{\theta}_{P1}\}}\left(\frac{\alpha\theta_2}{(k_2^S)^{1-\alpha}}\right)\right]\right] \\ & + \mathbb{E}_1\left[\mathbb{1}_{\{h > H(\theta_2, k_2^S)\}}\left[\mathbb{1}_{\{\theta_2 \geq \hat{\theta}_{P2}\}}\left(\frac{\alpha\theta_2}{(k_2^S)^{1-\alpha}}\right)\right]\right]. \end{aligned} \tag{3.21}$$

From (3.21), the effect of CDS on investment policy is determined by the exogenous level of credit protection h relative to H, which is determined by firm characteristics.

If the probability that creditors force a liquidation is low ($h \leq H(\theta_2, k_2^S)$):

$$\begin{aligned} & k_2^E < k_2^S \leq k_2^F, \quad \text{for } 0 \leq q < 1, \\ & k_2^E = k_2^S < k_2^F, \quad \text{for } q = 1. \end{aligned}$$

If the probability that creditors force a liquidation is high ($h > H(\theta_2, k_2^S)$):

$$\begin{aligned} & k_2^S < k_2^E < k_2^F, \quad \text{for } 0 \leq q < 1, \\ & k_2^S = k_2^E < k_2^F, \quad \text{for } q = 1. \end{aligned}$$

Proof. See Appendix. □

Surprisingly, we find that the CDS contract is not as effective in mitigating investment-related agency distortions as it is in reducing strategic default. On the contrary, the effect of CDS trading on underinvestment distortions is ambiguous, and it is not clear a priori whether the positive or the negative effect dominates. The ambiguity of its effect is driven by two economic forces conditional on the likelihood of the renegotiation (liquidation) event (see Proposition 3.8).

When the probability that creditors force a liquidation is low and debt renegotiation is feasible, $h \leq H(\theta_2, k_2)$, CDSs reduce underinvestment. By reducing shareholders' strategic default incentive, CDSs increase creditors' incentive to renegotiate debt owing to improved firm financial stability. Recall from Proposition 3.8, the greater capital stock, the higher the threshold $H(\theta_2, k_2)$, and the lower the empty creditor threat. Consequently, when renegotiation of the debt is feasible, the equity holders can adjust their optimal investment policy by increasing the capital to make renegotiation more attractive to the creditors.

In contrast, when the probability that creditors force a liquidation is high and debt renegotiation is impossible, $h > H(\theta_2, k_2)$, CDSs enhance distortions of the optimal investment. In other words, shareholders, fearing forceful liquidation caused by empty creditors and sharing the return of equity-financed investment with debt holders in default, will pass up valuable investment opportunities. This result is also consistent with the recent theoretical study of Wong and Yu (2018), who in a Leland's (1994) type of model with dynamic investment opportunities show that the CDS market drives debt overhang through the empty creditor channel. They demonstrate that debt holders excessively hedge against credit risk compared to the socially optimal credit insurance, which also increases the debt overhang problem.

In addition, our model predicts that the more bargaining power the equity holders have, the bigger the investment distortion CDSs create. This observation is in line with empirical findings of Colonnello, Efing, and Zucchi (2019), who document a reduction in investment in CDS firms with strong shareholders. They argue that this result can be explained by creditors' tendency to over-insure in the presence of powerful shareholders to strengthen their bargaining position in debt renegotiations. Consistent with a view that equity holders have more bargaining power than bondholders, CDSs may lead to a significant increase in financial agency costs.[17] As

[17]For instance, Davydenko and Strebulaev (2007) document that the risk that equity holders take advantage of a stronger bargaining position is substantial enough to affect bond spreads. Similarly,

a result, borrowers that are most affected by the empty creditor problem are more likely to face adverse effects of CDS trading on their default risk, investment activity and firm value.

Overall, the two forces, positive and negative effects, described above are partially offsetting each other, creating an interesting and not obvious trade-off between them. As a result, the effect of CDSs on investment-related agency costs is ambiguous.

3.4.3. Summary

The analysis on the potential interaction between debt covenants and CDSs indicates that the use of credit protection by creditors cannot replace the role of covenants in a loan agreement. A potential interaction between the two tools exists just for the part of their ability to reduce the incidence of strategic debt service. However, as of reducing investment-related agency costs, the tools are not equally effective. While covenants restore the shareholders' investment incentive reduced by debt overhang, the effect of CDS trading on underinvestment is ambiguous. In other words, CDSs can both alleviate or exacerbate the debt overhang problem.

Taken together, our model does not support the inference of empirical studies suggesting that a contractual protection can be replaced by CDS trading. Rather, our findings demonstrate that debt covenants are a more universal tool for debt protection and so the reason of a negative correlation observed empirically between covenants and CDSs might be found elsewhere.

3.5. Equity Maximization With Covenants and CDS

In this section, in light of the results of the previous section, we examine the rationality of using both instruments at the same time and if the presence of one instrument changes the incentives to use the other. Based on the analysis introduced in Section 3.4, we consider case of equity maximization in the presence of both a debt covenant and a CDS contract (see Figure 3.1 with the covenant restriction and $h > 0$). To differentiate from the unconstrained equity maximization in Section 3.3.3, we use a tilde to denote the updated value of variables.

Garlappi and Yan (2011) show the effect of higher shareholder bargaining power relative to debt holders on equity beta and return volatility.

The payoff to equity at $t = 2$ is identical to the CDS constrained equity maximization in (3.17), but adjusted by an after-repayment debt, $b - f$, similarly to the covenant constrained equity maximization in Section 3.4.1:[18]

$$\tilde{E}(\theta_2, k_2, b - f, h) = \begin{cases} \max\{\theta_2 k_2^\alpha - (b - f), \theta_2 k_2^\alpha - \tilde{b}_r\}, & \text{if } h \leq \tilde{H} \\ \max\{\theta_2 k_2^\alpha - (b - f), 0\}, & \text{if } h > \tilde{H}. \end{cases}$$

At $t = 1$, under the constraint on shareholders' investment policy, $k_2 \geq \underline{k}_2$, aimed to maintain the expected Debt/EBITDA ratio at the required level c^*, the equity value is

$$\tilde{E}(\theta_1, k_1, b, h) = \max_{k_2 \geq \underline{k}_2} \theta_1 k_1^\alpha - k_2 - f + \mathbb{E}_1[\tilde{E}(\theta_2, k_2, b - f, h)]. \tag{3.22}$$

The optimal investment policy at $t = 1$ based on equation (3.22) is summarized in the following proposition.

Proposition 3.11 (**Optimal investment policy with Covenant & CDS**). *For a firm with outstanding debt and costless external equity, the investment policy maximizing the equity value at $t = 1$ is $\tilde{k}_2$, which solves*

$$\begin{aligned} 1 = \mu & \\ &+ \mathbb{E}_1\left[\mathbb{1}_{\{h \leq \tilde{H}(\theta_2, \tilde{k}_2)\}}\left[\mathbb{1}_{\{\theta_2 < \tilde{\theta}_{P1}\}}\left(\frac{\alpha\theta_2}{\tilde{k}_2^{1-\alpha}}\right) \cdot (1 - \lambda(h))\right]\right] \\ &+ \mathbb{E}_1\left[\mathbb{1}_{\{h \leq \tilde{H}(\theta_2, \tilde{k}_2)\}}\left[\mathbb{1}_{\{\theta_2 \geq \tilde{\theta}_{P1}\}}\left(\frac{\alpha\theta_2}{\tilde{k}_2^{1-\alpha}}\right)\right]\right] \\ &+ \mathbb{E}_1\left[\mathbb{1}_{\{h > \tilde{H}(\theta_2, \tilde{k}_2)\}}\left[\mathbb{1}_{\{\theta_2 \geq \tilde{\theta}_{P2}\}}\left(\frac{\alpha\theta_2}{\tilde{k}_2^{1-\alpha}}\right)\right]\right]. \end{aligned} \tag{3.23}$$

If the probability that creditors force a liquidation is low ($h \leq \tilde{H}(\theta_2, \tilde{k}_2)$), the combination of the debt covenant with CDS trading is more effective in mitigating underinvestment than what each instrument does individually, given that $k_2^S \leq \tilde{k}_2 \leq k_2^F$ and $k_2^C \leq \tilde{k}_2 \leq k_2^F$.

If the probability that creditors force a liquidation is high ($h > \tilde{H}(\theta_2, \tilde{k}_2)$), for creditor bargaining power $q < 1$, the covenant proves ineffective in mitigting underin-

[18] By adjusting the payoff to equity at $t = 2$, we also update the value of renegotiated debt $\hat{b}_r(\theta_2, k_2, b, h)$, the credit protection threshold $H(\theta_2, k_2, b)$, the renegotiation threshold $\hat{\theta}_{P1}(k_2, b, h)$ and the default threshold $\hat{\theta}_{P2}(k_2, b)$ determined in Section 3.4.2.

vestment, given that $k_2^S \leq \tilde{k}_2 \leq k_2^E \leq k_2^C \leq k_2^F$.

Proof. See Appendix. □

When the probability that creditors force a liquidation is low, the combination of instruments provides the greater protection of debt from investment-related agency conflicts due to increased renegotiation frictions in the presence of CDS trading than each instrument does individually, $k_2^E \leq k_2^S \leq \tilde{k}_2 \leq k_2^F$ and $k_2^E \leq k_2^C \leq \tilde{k}_2 \leq k_2^F$. That is in line with findings by Gamba and Mao (2019), who demonstrate that the presence of frictions limiting ex post renegotiation of the debt contract is essential to make covenants an useful commitment device. On the contrary, when renegotiation is ruled out and there is a chance of inefficient liquidation, the presence of covenant in the loan agreement makes the underinvestment problem less severe. However, it does not solve the problem completely. When shareholders have at least some bargaining power, $q < 1$, the covenant proves ineffective in the presence of CDS trading given that underinvestment is still the equilibrium outcome, $k_2^S \leq \tilde{k}_2 \leq k_2^E$. Expecting a forceful liquidation in next period with no chance to renegotiate the debt, the equity holders underinvest despite the presence of the covenant in the credit agreement. Such loss of covenant effectiveness provides an explanation to the empirical findings of Chakraborty, Chava, and Ganduri (2015), who document no creditors' intervention in investment policies in CDS traded firms, including those with agency problems, following covenant violations. In other words, the loss of covenant effectiveness can be much broader, and be also related to its ex post discipling effects on corporate policies following the covenant violations.

Next, we examine the rationality for creditors to have two commitment mechanisms at the same time to address the incidence of strategic debt service. We find that the combination of the two instruments together is even more effective in reducing the likelihood of strategic default than instruments can achieve individually. The model with the equity maximization in the presence of both covenants and CDSs generates the lowest renegotiation/default thresholds than in the unconstrained case and in the presence of a single instrument. Furthermore, we find that covenants allow to reduce the likelihood of inefficient liquidation caused by CDS-protected empty creditors. The default threshold in the presence of both covenants and CDSs is lower than the one in the presence of just credit insurance. The following findings are summarized in the next proposition.

Proposition 3.12 (Covenant & CDS and strategic default).

1. *Debt covenant and CDS are more efficient in reducing the likelihood of strategic default together rather than individually, given that*

$$\tilde{\theta}_P \leq \bar{\theta}_P < \theta_P,$$
$$\tilde{\theta}_P < \hat{\theta}_P \leq \theta_P,$$

where $\bar{\theta}_P$ is the renegotiation threshold with the covenant, $\hat{\theta}_P$ (either $\hat{\theta}_{P1}$ or $\hat{\theta}_{P2}$) is the renegotiation/default threshold with CDS, and $\tilde{\theta}_P$ (either $\tilde{\theta}_{P1}$ or $\tilde{\theta}_{P2}$) is the renegotiation/default threshold with both the covenant and CDS.

2. *The presence of the covenant allows to reduce the probability of inefficient liquidation caused by CDS-protected empty creditors, i.e. for $h > \tilde{H}(\theta_2, \tilde{k}_2)$, given that*

$$\tilde{\theta}_{P2} \leq \hat{\theta}_{P2} \leq \theta_P.$$

Proof. See Appendix. □

Taken together, our findings indicate that the CDS market indeed can affect creditors' incentives to use traditional tools of financial contracting such as debt covenants. That provides a consistent explanation for the empirical findings of Shan, Tang, and Winton (2019), who document less strict covenants in new loans of CDS-traded firms. But the reason of the reduced incentive of creditors to impose covenants in loan agreements lies not in the substitutive effect of CDS trading, rather in its detrimental effect on covenant effectiveness. The effectiveness of covenants as a tool alleviating distortions of the optimal investment policy is mainly determined by the probability that creditors turn into empty creditors and force a liquidation. When there is a high risk for borrowers to be affected by empty creditors, covenants prove ineffective given that underinvestment is still the equilibrium outcome. Notwithstanding the potential loss of covenant effectiveness, the joint use of covenants and CDSs allows to achieve the greatest reduction in the wealth transfer from debt to equity caused by future strategic debt service, and the reduction in the likelihood of inefficient liquidation caused by CDS-protected empty creditors.

3.6. Conclusion

In this study, we analyse whether creditors' incentive to use traditional tools of financial contracting, such as debt covenants, change following the introduction of CDS trading on a borrower debt. In a two-period model, we consider an equity-maximizing firm with outstanding debt, that optimally makes investment and default decisions under limited commitment. The model generates a couple of known debt-equity agency conflicts, such as underinvestment and strategic default. In this debt overhang setup, we explore whether CDS contracts are equally effective with debt covenants used by creditors to reduce debt-equity agency frictions, and whether the presence of CDS trading changes covenants' effectiveness.

We find that the access of debt holders to credit insurance can indeed reduce their incentive to impose covenants on loan agreements. But the reason of this reduced incentive lies not in the substitutive effect of the CDS market discussed broadly in empirical literature, rather in its detrimental effect on covenant effectiveness. Our model demonstrates debt covenants as a more universal tool for debt protection, the effectiveness of which can be affected by the introduction of CDSs. Specifically, the effectiveness of covenants as a tool alleviating investment-related agency costs is mainly determined by the probability that creditors turn into empty creditors and force a liquidation. When there is a high risk for borrowers being affected by empty creditors, shareholders, expecting forceful liquidation in next period with no chance to renegotiate debt, underinvest despite the presence of debt covenants in a credit agreement.

These findings can be useful for regulators in policy discussion with respect to the welfare effects of the CDS market. Notwithstanding the potential loss of covenant effectiveness following the introduction of CDS trading, debt holders should be particularly careful in loosening strictness of covenants in credit contracts given its complementary value in reducing the incidence of strategic debt service and the likelihood of inefficient liquidation caused by CDS-protected empty creditors.

3.7. Appendix

Appendix A. Proof of propositions

Proposition 3.1

At $t = 1$, the optimal capital level for next period, k_2, is a maximand of

$$\max_{k_2 \geq 0} \theta_1 k_1^\alpha - k_2 + \mathbb{E}_1[F(\theta_2,k_2)],$$

where $\mathbb{E}_1[F(\theta_2, k_2)] = \int \theta_2 k_2^\alpha \, \psi(\theta_2) d\theta_2$. Then, first order condition is

$$-1 + \mathbb{E}_1 \left[\frac{\alpha \theta_2}{k_2^{1-\alpha}} \right] = 0,$$

that is equation (3.3).

At $t = 0$, the optimal capital level for next period, k_1, is a maximand of

$$\max_{k_1 \geq 0} \theta_0 k_0^\alpha - k_1 + \mathbb{E}_0[F(\theta_1,k_1)],$$

where $\mathbb{E}_0[F(\theta_1, k_1)] = \int \left(\theta_1 k_1^\alpha - k_2^F + \mathbb{E}_1[F(\theta_2, k_2^F)] \right) \psi(\theta_1) d\theta_1$. Then, first order condition is

$$-1 + \mathbb{E}_0 \left[\frac{\alpha \theta_1}{k_1^{1-\alpha}} \right] = 0,$$

that is equation (3.3).

Proposition 3.3

At $t = 1$, the equity holders make a decision on the capital level for next period, k_2, in order to maximize the value of equity at that date,

$$\max_{k_2 \geq 0} \theta_1 k_1^\alpha - k_2 + \mathbb{E}_1[E(\theta_2, k_2)],$$

where

$$
\begin{aligned}
&\mathbb{E}_1[E(\theta_2, k_2)] = \\
&= \int_0^{\theta_P(k_2)} \left[\theta_2 k_2^\alpha - b_r(\theta_2, k_2)\right] \psi(\theta_2) d\theta_2 + \int_{\theta_P(k_2)}^{\infty} \left[\theta_2 k_2^\alpha - b\right] \psi(\theta_2) d\theta_2 \\
&= \int_0^{\theta_P(k_2)} \left[\theta_2 k_2^\alpha \cdot (1-\lambda)\right] \psi(\theta_2) d\theta_2 + \int_{\theta_P(k_2)}^{\infty} \left[\theta_2 k_2^\alpha - b\right] \psi(\theta_2) d\theta_2,
\end{aligned}
$$

and

$$
\theta_P(k_2) = \frac{b}{k_2^\alpha} \cdot \frac{1}{\lambda}.
$$

Then, first order condition by Leibniz integral rule is

$$
\begin{aligned}
-1 &+ \left[\frac{\partial \theta_P}{\partial k_2} \cdot \frac{b}{\lambda} (1-\lambda) \psi(\theta_P) + \int_0^{\theta_P(k_2)} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}}\right) \cdot (1-\lambda) \psi(\theta_2) d\theta_2\right] \\
&+ \left[-\frac{\partial \theta_P}{\partial k_2} \cdot \left(\frac{b}{\lambda} - b\right) \psi(\theta_P) + \int_{\theta_P(k_2)}^{\infty} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}}\right) \psi(\theta_2) d\theta_2\right] \\
= -1 &+ \mathbb{E}_1 \left[\mathbb{1}_{\{\theta_2 < \theta_P\}} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}}\right) \cdot (1-\lambda) + \mathbb{1}_{\{\theta_2 \geq \theta_P\}} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}}\right)\right] = 0,
\end{aligned}
$$

which is equation (3.7).

At $t = 0$, the optimal capital level for next period, k_1, is a maximand of

$$
\max_{k_1 \geq 0} \theta_0 k_0^\alpha - k_1 + \mathbb{E}_0[E(\theta_1, k_1)],
$$

where $\mathbb{E}_0[E(\theta_1, k_1)] = \int \left(\theta_1 k_1^\alpha - k_2^E + \mathbb{E}_1[E(\theta_2, k_2^E)]\right) \psi(\theta_1) d\theta_1$. Then, first order condition is

$$
-1 + \mathbb{E}_0 \left[\frac{\alpha\theta_1}{k_1^{1-\alpha}}\right] = 0,
$$

that is equation (3.8).

Proposition 3.4

1. The possibility of strategic debt service is summarized in Proposition 3.2 based on equation (3.4).

2. To prove an incentive to underinvest, $k_2^E < k_2^F$, we denote as $\Phi_F(k_2)$ the marginal benefits of capital for the firm maximizing policy and as $\Phi_E(k_2)$ the

marginal benefits of capital for the equity-maximizing policy based on the results of Propositions 3.1 and 3.3 (see equations (3.3) and (3.7), respectively):

$$\Phi_F(k_2) = \mathbb{E}_1 \left[\frac{\alpha\theta_2}{(k_2)^{1-\alpha}} \right], \tag{3.24}$$

$$\Phi_E(k_2) = \mathbb{E}_1 \left[\mathbb{1}_{\{\theta_2 < \theta_P\}} \left(\frac{\alpha\theta_2}{(k_2)^{1-\alpha}} \right) \cdot (1-\lambda) + \mathbb{1}_{\{\theta_2 \geq \theta_P\}} \left(\frac{\alpha\theta_2}{(k_2)^{1-\alpha}} \right) \right], \tag{3.25}$$

where the renegotiation threshold $\theta_P(k_2)$ is a function of capital level k_2 and $0 \leq 1-\lambda < 1$ under the initial parameter assumptions.[19]

The comparison of marginal benefits of capital of two different programs for the same capital level, k_2, implies that

$$\Phi_E(k_2) - \Phi_F(k_2) = \int_0^{\theta_P} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}} \right) \cdot (-\lambda)\, \psi(\theta_2) d\theta_2 < 0.$$

Consequently, $\Phi_E(k_2) < \Phi_F(k_2)$, which is graphically represented in Figure 3.2. The marginal costs of capital in the two scenarios are identical and equal to 1, given the absence of dividend constraints and equity issuance costs. That allows us to compare two optimal polices by expecting that a firm invests in capital until the marginal cost of capital is equal to the marginal benefit of capital, which implies that $k_2^E < k_2^F$.

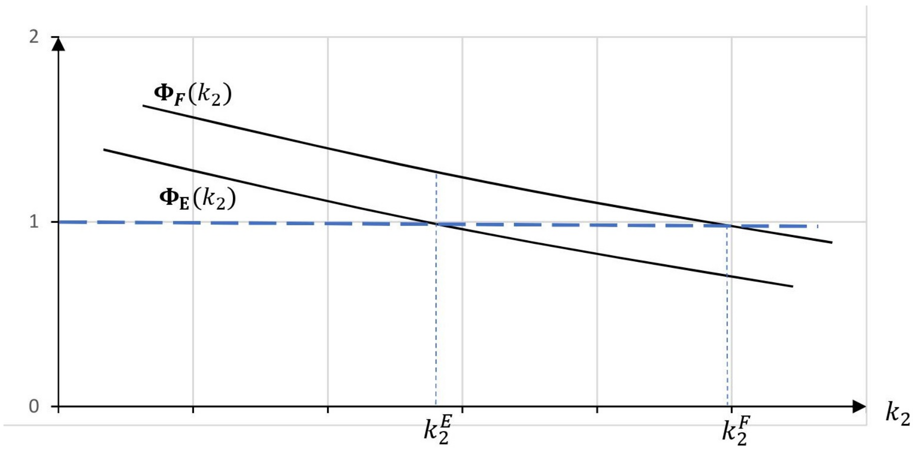


Figure 3.2: Optimal investment policy: equity maximization vs. firm value maximization

[19]Where $\lambda = q + \ell(1-q)$, $0 < \lambda \leq 1$ given $q \in [0,1]$ and $\ell \in (0,1)$.

Proposition 3.6

Under the constraint on shareholders' investment policy, $k_2 \geq \underline{k_2}$, aimed to maintain the expected Debt/EBITDA ratio at the required level c^*, the optimal capital level k_2 is the maximand of

$$\max \theta_1 k_1^\alpha - k_2 - f + \mathbb{E}_1[\bar{E}(\theta_2, k_2, b - f)],$$

which is also subject to

$$k_2 \geq \underline{k_2} = \left(\frac{b-f}{c^* \bar{\theta}_2}\right)^{1/\alpha}.$$

The Lagrangian is defined by

$$\mathcal{L} = \theta_1 k_1^\alpha - k_2 - f + \mathbb{E}_1[\bar{E}(\theta_2, k_2, b - f)] - \mu \left(-k_2 + \left(\frac{b-f}{c^* \bar{\theta}_2}\right)^{1/\alpha}\right),$$

where μ is a Lagrange multiplier of the inequality constraint.

Then, first order condition is

$$\begin{aligned}
0 &= -1 + \mu \\
&+ \left[\frac{\partial \bar{\theta}_P}{\partial k_2} \cdot \frac{b-f}{\lambda}(1-\lambda)\psi(\theta_2) + \int_0^{\bar{\theta}_P} \frac{\alpha \theta_2}{k_2^{1-\alpha}} \cdot (1-\lambda)\, \psi(\theta_2) d\theta_2\right] \\
&+ \left[-\frac{\partial \bar{\theta}_P}{\partial k_2} \cdot \left(\frac{b-f}{\lambda} - (b-f)\right) \psi(\theta_2) + \int_{\bar{\theta}_P}^{\infty} \frac{\alpha \theta_2}{k_2^{1-\alpha}}\, \psi(\theta_2) d\theta_2\right] \\
&= -1 + \mu + \mathbb{E}\left[\mathbb{1}_{\{\theta_2 < \bar{\theta}_P\}} \left(\frac{\alpha \theta_2}{k_2^{1-\alpha}}\right) \cdot (1-\lambda) + \mathbb{1}_{\{\theta_2 \geq \bar{\theta}_P\}} \left(\frac{\alpha \theta_2}{k_2^{1-\alpha}}\right)\right],
\end{aligned}$$

which is equation (3.13), with complementary slackness conditions:

$$\begin{aligned}
&\mu \left(-k_2 + \left(\frac{b-f}{c^* \bar{\theta}_2}\right)^{1/\alpha}\right) = 0, \\
&\mu \geq 0, \\
&k_2 \geq \underline{k_2},
\end{aligned}$$

where the constraint is binding, $k_2 = \underline{k_2}$, when $\mu > 0$.

To prove that $k_2^E \leq k_2^C \leq k_2^F$, first, we denote the marginal benefits of capital for the covenant constrained equity maximization as $\Phi_C(k_2)$ and compare it with the marginal benefits of capital of the baseline equity maximization with no covenants, $\Phi_E(k_2)$ (3.25):

$$\Phi_C(k_2) = \mathbb{E}_1 \left[\mathbb{1}_{\{\theta_2 < \bar{\theta}_P\}} \left(\frac{\alpha\theta_2}{(k_2)^{1-\alpha}} \right) \cdot (1-\lambda) + \mathbb{1}_{\{\theta_2 \geq \bar{\theta}_P\}} \left(\frac{\alpha\theta_2}{(k_2)^{1-\alpha}} \right) \right] + \mu. \tag{3.26}$$

Given $\bar{\theta}_P \leq \theta_P$ (see proof of Proposition 3.7), $0 < \lambda \leq 1$ and $\mu \geq 0$, it implies that for $\bar{\theta}_P < \theta_P$ (i.e., when $f > 0$)

$$\Phi_C(k_2) - \Phi_E(k_2) = \int_{\bar{\theta}_P}^{\theta_P} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}} \right) \cdot \lambda\, \psi(\theta_2) d\theta_2 + \mu > 0,$$

and for $\bar{\theta}_P = \theta_P$ (i.e., when $f = 0$), $\Phi_C(k_2) - \Phi_E(k_2) = \mu \geq 0$.

Consequently, for shareholders reducing the debt by amount $f > 0$ to ensure the covenant compliance $\Phi_C(k_2) > \Phi_E(k_2)$ and $k_2^C > k_2^E$ (see Figure 3.3), whereas for $f = 0$, $\Phi_C(k_2) \geq \Phi_E(k_2)$ and $k_2^C \geq k_2^E$.

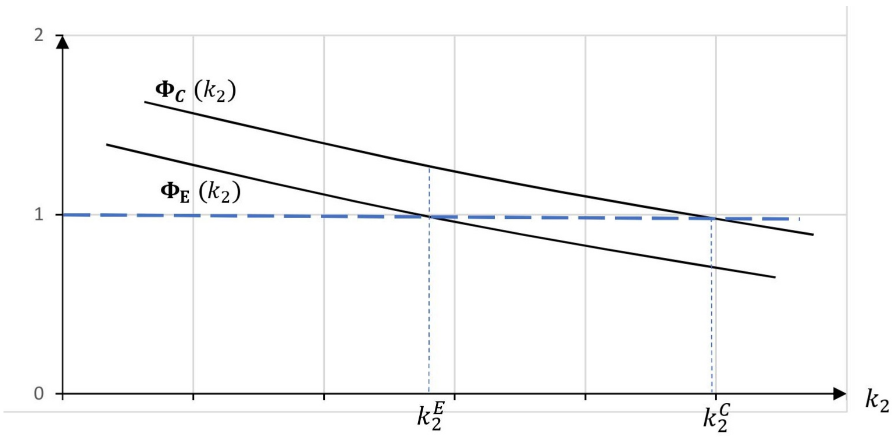


Figure 3.3: Optimal investment policy: unconstrained equity maximization vs. covenant constrained equity maximization

With respect to $\Phi_C(k_2)$ compared to the marginal benefits of capital of the firm maximization, $\Phi_F(k_2)$ (3.24), we have:

$$\Phi_C(k_2) - \Phi_F(k_2) = \int_0^{\bar{\theta}_P} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}} \right) \cdot (-\lambda)\, \psi(\theta_2) d\theta_2 + \mu \leq 0.$$

Consequently, $\Phi_C(k_2) \leq \Phi_F(k_2)$ and $k_2^C \leq k_2^F$.

Proposition 3.9

CDS reduces the occurrence of strategic default at $t = 2$. The renegotiation/default thresholds in the presence of CDS are below or equal to the threshold in the unconstrained case, $\hat{\theta}_{P1} \leq \theta_P$ and $\hat{\theta}_{P2} \leq \theta_P$, given that $b \geq b(1-h(1-q))$ and $0 \leq \lambda(h) \leq 1$ under initial parameter assumptions,[20] where

$$\begin{aligned}
\theta_P(k_2,b) &= \frac{b}{k_2^{\alpha}} \cdot \frac{1}{\lambda(h)},\\
\hat{\theta}_{P1}(k_2,b,h) &= \frac{b(1-h(1-q))}{k_2^{\alpha}} \cdot \frac{1}{\lambda(h)},\\
\hat{\theta}_{P2}(k_2,b) &= \frac{b}{k_2^{\alpha}},\\
\lambda(h) &= q + (1-h)\ell(1-q).
\end{aligned}$$

1. For $h \leq H$, when renegotiation is feasible, the higher k_2 (or the higher hedge ratio h), the lower the probability of strategic default.

1.1. The renegotiation threshold $\hat{\theta}_{P1}(k_2,b,h)$ is decreasing in k_2:

$$\frac{\partial \hat{\theta}_{P1}}{\partial k_2} = -\alpha \frac{b(1-h(1-q))}{k_2^{1+\alpha}} \cdot \frac{1}{\lambda(h)} < 0.$$

1.2. To prove that the renegotiation threshold $\hat{\theta}_{P1}(k_2,b,h)$ is decreasing in h, we denote $u(b,h) = b(1-h(1-q))$ and $v(k_2,h) = k_2^{\alpha}[q+(1-h)\ell(1-q)]$, $\hat{\theta}_{P1}(k_2,b,h) = \frac{u}{v}$.

Then,

$$\begin{aligned}
\frac{\partial \hat{\theta}_{P1}}{\partial h} &= \frac{-vb(1-q) - (-u\ell k_2^{\alpha}(1-q))}{v^2}\\
&= \frac{(1-q)\cdot[u\ell k_2^{\alpha} - vb]}{v^2},
\end{aligned}$$

[20] In the baseline equity maximization case with no CDS, $0 < \lambda(h) \leq 1$ given that $h = 0$.

where $\partial\hat{\theta}_{P1}/\partial h < 0$ given that $u\ell k_2^\alpha \leq vb$:

$$\begin{aligned} u\ell k_2^\alpha &\leq vb, \\ b(1-h(1-q))\ell k_2^\alpha &\leq bk_2^\alpha[q+(1-h)\ell(1-q)], \\ \ell &\leq q+\ell(1-q). \end{aligned}$$

2. For $h > H$, renegotiation is ruled out. As a result, when $\theta_2 < \hat{\theta}_{P2}$, CDS can give rise to inefficient liquidation ex post by forcing the firm into bankruptcy even though renegotiation would be efficient.

Proposition 3.10

At $t = 1$, the equity holders make a decision on the capital level for next period, k_2, in order to maximize the value of equity at that date,

$$\hat{E}(\theta_1, k_1, b, h) = \max_{k_2 \geq 0} \theta_1 k_1^\alpha - k_2 + \mathbb{E}_1[\hat{E}(\theta_2, k_2, b, h)],$$

where

$$\begin{aligned} &\mathbb{E}_1[\hat{E}(\theta_2, k_2, b, h)] = \mathbb{E}_1[\mathbb{1}_{\{h \leq H\}}\hat{E}(\theta_2, k_2, b, h) + \mathbb{1}_{\{h > H\}}\hat{E}(\theta_2, k_2, b, h)] \\ &= \mathbb{E}_1\left[\mathbb{1}_{\{h \leq H(k_2)\}}\left[\mathbb{1}_{\{\theta_2 < \hat{\theta}_{P1}(k_2)\}}\left(\theta_2 k_2^\alpha - \hat{b}_r\right) + \mathbb{1}_{\{\theta_2 \geq \hat{\theta}_{P1}(k_2)\}}(\theta_2 k_2^\alpha - b)\right]\right] \\ &+ \mathbb{E}_1\left[\mathbb{1}_{\{h > H(k_2)\}}\left[\mathbb{1}_{\{\theta_2 \geq \hat{\theta}_{P2}(k_2)\}}(\theta_2 k_2^\alpha - b)\right]\right] \\ &= \mathbb{1}_{\{h \leq H(k_2)\}}\left[\int_0^{\hat{\theta}_{P1}(k_2)} [\theta_2 k_2^\alpha \cdot (1-\lambda(h)) - hb(1-q)]\ \psi(\theta_2)d\theta_2\right] \\ &+ \mathbb{1}_{\{h \leq H(k_2)\}}\left[\int_{\hat{\theta}_{P1}(k_2)}^\infty [\theta_2 k_2^\alpha - b]\,\psi(\theta_2)d\theta_2\right] \\ &+ \mathbb{1}_{\{h > H(k_2)\}}\left[\int_{\hat{\theta}_{P2}(k_2)}^\infty [\theta_2 k_2^\alpha - b]\,\psi(\theta_2)d\theta_2\right], \end{aligned}$$

and

$$\begin{aligned}
\hat{\theta}_{P1}(k_2,h) &= \frac{b(1-h(1-q))}{k_2^{\alpha}} \cdot \frac{1}{\lambda(h)}, \\
\hat{\theta}_{P2}(k_2) &= \frac{b}{k_2^{\alpha}}, \\
H(k_2) &= \frac{\theta_2 k_2^{\alpha} \cdot (1-\ell)}{b - \ell\theta_2 k_2^{\alpha}}, \\
\hat{b}_r(k_2,h) &= hb\,(1-q) + \theta_2 k_2^{\alpha} \cdot \lambda(h).
\end{aligned}$$

Then, first order condition by Leibniz integral rule is

$$\begin{aligned}
0 &= -1 \\
&+ \mathbb{1}_{\{h\leq H\}} \left[\left(\frac{\partial \hat{\theta}_{P1}}{\partial k_2} \cdot \frac{b(1-h(1-q))}{\lambda(h)} \cdot (1-\lambda(h)) - hb(1-q) \right) \psi(\hat{\theta}_{P1}) \right] \\
&+ \mathbb{1}_{\{h\leq H\}} \left[\int_0^{\hat{\theta}_{P1}} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}} \right) \cdot (1-\lambda(h))\, \psi(\theta_2) d\theta_2 \right] \\
&+ \mathbb{1}_{\{h\leq H\}} \left[-\frac{\partial \hat{\theta}_{P1}}{\partial k_2} \cdot \left(\frac{b(1-h(1-q))}{\lambda(h)} - b \right) \psi(\hat{\theta}_{P1}) + \int_{\hat{\theta}_{P1}}^{\infty} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}} \right) \psi(\theta_2) d\theta_2 \right] \\
&+ \mathbb{1}_{\{h>H\}} \left[-\frac{\partial \hat{\theta}_{P2}}{\partial k_2} \cdot 0 \cdot \psi(\hat{\theta}_{P2}) + \int_{\hat{\theta}_{P2}}^{\infty} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}} \right) \psi(\theta_2) d\theta_2 \right] \\
&= -1 \\
&+ \mathbb{E}_1 \left[\mathbb{1}_{\{h\leq H\}} \left[\mathbb{1}_{\{\theta_2 < \hat{\theta}_{P1}\}} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}} \right) \cdot (1-\lambda(h)) + \mathbb{1}_{\{\theta_2 \geq \hat{\theta}_{P1}\}} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}} \right) \right] \right] \\
&+ \mathbb{E}_1 \left[\mathbb{1}_{\{h>H\}} \left[\mathbb{1}_{\{\theta_2 \geq \hat{\theta}_{P2}\}} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}} \right) \right] \right],
\end{aligned}$$

which is equation (3.21).

The effect of CDS on investment policy is determined by the exogenous level of credit protection h relative to H, which is determined based on firm characteristics, we consider scenarios $h \leq H(k_2)$ and $h > H(k_2)$ separately.

- *When renegotiation is feasible at $t = 2$ ($h \leq H(k_2)$):*

First, we denote as $\Phi_S(k_2)$ the marginal benefits of capital in the equity maximization in the presence of CDS trading based on equation (3.21) and compare it with the marginal benefits of capital of the baseline equity maximization with no

CDS based on equation (3.25) for the same capital level k_2:

$$\Phi_S(k_2) = \mathbb{E}_1 \left[\mathbb{1}_{\{\theta_2 < \hat{\theta}_{P1}\}} \left(\frac{\alpha \theta_2}{(k_2)^{1-\alpha}} \right) (1 - \lambda(h)) + \mathbb{1}_{\{\theta_2 \geq \hat{\theta}_{P1}\}} \left(\frac{\alpha \theta_2}{(k_2)^{1-\alpha}} \right) \right]. \tag{3.27}$$

When the creditor bargaining power is $q = 1$, $\hat{\theta}_{P1} = \theta_P$ and $\lambda(h = 0) = \lambda(h)$, which make marginal benefits of the two programs identical: $\Phi_S(k_2) - \Phi_E(k_2) = 0$. Consequently, $k_2^S = k_2^E$.

For the creditor bargaining power $q < 1$, $\hat{\theta}_{P1} < \theta_P$, that implies that for the same capital level $\Phi_S(k_2) > \Phi_E(k_2)$ (see Figure 3.4, Panel A):

$$\Phi_S(k_2) - \Phi_E(k_2) = \int_{\hat{\theta}_{P1}}^{\theta_P} \left(\frac{\alpha \theta_2}{k_2^{1-\alpha}} \right) \cdot \lambda(h = 0)\, \psi(\theta_2) d\theta_2 > 0,$$

where $\lambda(h = 0) > 0$. Consequently, $k_2^S > k_2^E$.

With respect to $\Phi_S(k_2)$ compared to the marginal benefits of capital of the firm maximization based on equation (3.24), we have:

$$\Phi_S(k_2) - \Phi_F(k_2) = \int_0^{\hat{\theta}_{P1}} \left(\frac{\alpha \theta_2}{k_2^{1-\alpha}} \right) \cdot (-\lambda(h))\, \psi(\theta_2) d\theta_2 \leq 0,$$

where $0 \leq \lambda(h) \leq 1$. Consequently, $\Phi_S(k_2) \leq \Phi_F(k_2)$. Given that a firm invests in capital until the marginal costs of capital are equal to the marginal benefits of capital, $k_2^S \leq k_2^F$.

Overall, $k_2^E \leq k_2^S \leq k_2^F$. The optimal capital choice in the presence of CDSs is above the one for the unconstrained equity maximization, when the creditor bargaining power is $q < 1$:

$$\begin{array}{lll} k_2^S = k_2^E, & \text{for } q = 1, & 0 < h \leq 1 \\ k_2^S > k_2^E, & \text{for } 0 \leq q < 1, & 0 < h \leq 1 \\ k_2^S = k_2^F, & \text{for } q = 0, & h = 1 \end{array}$$

- *When renegotiation is ruled out at $t = 2$ ($h > H(k_2)$):*

The marginal benefits of capital in the equity maximization with CDS are

$$\Phi_S(k_2) = \mathbb{E}_1 \left[\mathbb{1}_{\{\theta_2 \geq \hat{\theta}_{P2}\}} \left(\frac{\alpha \theta_2}{(k_2)^{1-\alpha}} \right) \right]. \tag{3.28}$$

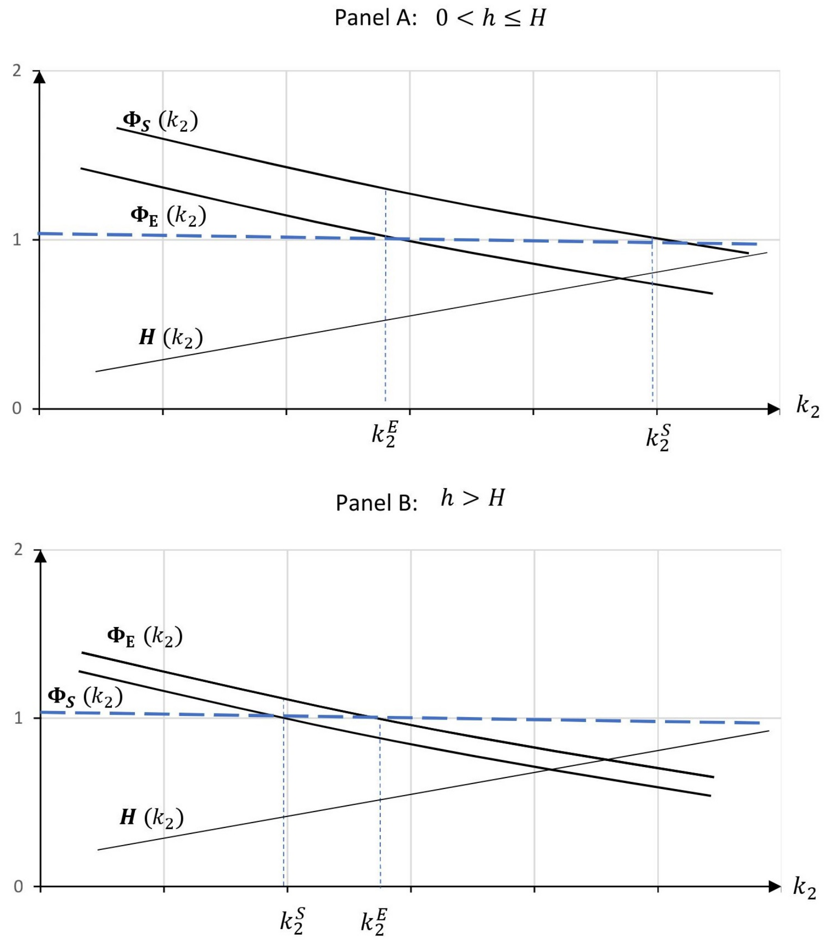


Figure 3.4: Optimal investment policy: unconstrained equity maximization vs. equity maximization with CDS

When the creditor bargaining power is $q = 1$, $\hat{\theta}_{P2} = \theta_P$ given that $\lambda(h = 0) = 1$, that makes marginal benefits of the equity maximization with CDS identical to those of without CDS, $\Phi_S(k_2) = \Phi_E(k_2)$. Consequently, $k_2^S = k_2^E$.

When the creditor bargaining power is $q < 1$, the fact that with CDS, on $\theta_2 < \hat{\theta}_{P2}$, the firm is liquidated and $\hat{\theta}_{P2}(k_2,b) < \theta_P(k_2,b)$, $0 < \lambda(h = 0) < 1$ implies that $\Phi_S(k_2) < \Phi_E(k_2)$ (see Figure 3.4, Panel B). Consequently, $k_2^S < k_2^E$.

The comparison of marginal benefits of capital of firm value maximization and equity maximization with CDS for the same capital level k_2 implies that $\Phi_S(k_2) < \Phi_F(k_2)$ given zero value in liquidation case (no renegotiation), on $\theta_2 < \hat{\theta}_{P2}$. Consequently, $k_2^S < k_2^F$.

Proposition 3.11

At $t = 1$, the equity holders make a decision on the capital level for next period, k_2, in order to maximize the value of equity at that date,

$$\tilde{E}(\theta_1, k_1, b, h) = \max \theta_1 k_1^\alpha - k_2 - f + \mathbb{E}_1[\tilde{E}(\theta_2, k_2, b - f, h)],$$

under the constraint aimed to maintain the expected Debt/EBITDA ratio at the required level c^*:

$$k_2 \geq \underline{k_2} = \left(\frac{b - f}{c^* \bar{\theta}_2}\right)^{1/\alpha}.$$

The Lagrangian is defined by

$$\mathcal{L} = \theta_1 k_1^\alpha - k_2 - f + \mathbb{E}_1[\tilde{E}(\theta_2, k_2, b - f, h)] - \mu \left(-k_2 + \left(\frac{b - f}{c^* \bar{\theta}_2}\right)^{1/\alpha}\right),$$

where μ is a Lagrange multiplier of the inequality constraint, and

$$\begin{aligned}
&\mathbb{E}_1[\tilde{E}(\theta_2, k_2, b - f, h)] = \mathbb{E}_1[\mathbb{1}_{\{h \leq \tilde{H}\}} \tilde{E}(\theta_2, k_2, b - f, h) + \mathbb{1}_{\{h > \tilde{H}\}} \tilde{E}(\theta_2, k_2, b - f, h)] \\
&= \mathbb{E}_1 \left[\mathbb{1}_{\{h \leq \tilde{H}(k_2)\}} \left[\mathbb{1}_{\{\theta_2 < \tilde{\theta}_{P1}(k_2)\}} \left(\theta_2 k_2^\alpha - \tilde{b}_r\right) + \mathbb{1}_{\{\theta_2 \geq \tilde{\theta}_{P1}(k_2)\}} (\theta_2 k_2^\alpha - (b - f))\right]\right] \\
&+ \mathbb{E}_1 \left[\mathbb{1}_{\{h > \tilde{H}(k_2)\}} \left[\mathbb{1}_{\{\theta_2 \geq \hat{\theta}_{P2}(k_2)\}} (\theta_2 k_2^\alpha - (b - f))\right]\right] \\
&= \mathbb{1}_{\{h \leq \tilde{H}(k_2)\}} \left[\int_0^{\tilde{\theta}_{P1}(k_2)} [\theta_2 k_2^\alpha \cdot (1 - \lambda(h)) - h(b - f)(1 - q)] \, \psi(\theta_2) d\theta_2\right] \\
&+ \mathbb{1}_{\{h \leq \tilde{H}(k_2)\}} \left[\int_{\tilde{\theta}_{P1}(k_2)}^{\infty} [\theta_2 k_2^\alpha - (b - f)] \, \psi(\theta_2) d\theta_2\right] \\
&+ \mathbb{1}_{\{h > \tilde{H}(k_2)\}} \left[\int_{\tilde{\theta}_{P2}(k_2)}^{\infty} [\theta_2 k_2^\alpha - (b - f)] \, \psi(\theta_2) d\theta_2\right],
\end{aligned}$$

and

$$\begin{aligned}
\tilde{\theta}_{P1}(k_2, f, h) &= \frac{(b - f)(1 - h(1 - q))}{k_2^\alpha} \cdot \frac{1}{\lambda(h)}, \\
\tilde{\theta}_{P2}(k_2) &= \frac{b - f}{k_2^\alpha}, \\
\tilde{H}(k_2) &= \frac{\theta_2 k_2^\alpha \cdot (1 - \ell)}{(b - f) - \ell \theta_2 k_2^\alpha}, \\
\tilde{b}_r(k_2, h) &= h(b - f)(1 - q) + \theta_2 k_2^\alpha \cdot \lambda(h).
\end{aligned}$$

Then, first order condition is

$$
\begin{aligned}
0 &= -1 + \mu \\
&+ \mathbb{1}_{\{h \leq \tilde{H}\}} \left[\left(\frac{\partial \tilde{\theta}_{P1}}{\partial k_2} \cdot \frac{(b-f)(1-h(1-q))}{\lambda(h)} \cdot (1-\lambda(h)) - h(b-f)(1-q) \right) \psi(\tilde{\theta}_{P1}) \right] \\
&+ \mathbb{1}_{\{h \leq \tilde{H}\}} \left[\int_0^{\tilde{\theta}_{P1}} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}} \right) \cdot (1-\lambda(h))\, \psi(\theta_2) d\theta_2 \right] \\
&+ \mathbb{1}_{\{h \leq \tilde{H}\}} \left[-\frac{\partial \tilde{\theta}_{P1}}{\partial k_2} \cdot \left(\frac{(b-f)(1-h(1-q))}{\lambda(h)} - (b-f) \right) \psi(\tilde{\theta}_{P1}) + \int_{\tilde{\theta}_{P1}}^{\infty} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}} \right) \psi(\theta_2) d\theta_2 \right] \\
&+ \mathbb{1}_{\{h > \tilde{H}\}} \left[-\frac{\partial \tilde{\theta}_{P2}}{\partial k_2} \cdot 0 \cdot \psi(\tilde{\theta}_{P2}) + \int_{\tilde{\theta}_{P2}}^{\infty} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}} \right) \psi(\theta_2) d\theta_2 \right] \\
&= -1 + \mu \\
&+ \mathbb{E}_1 \left[\mathbb{1}_{\{h \leq \tilde{H}\}} \left[\mathbb{1}_{\{\theta_2 < \tilde{\theta}_{P1}\}} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}} \right) \cdot (1-\lambda(h)) + \mathbb{1}_{\{\theta_2 \geq \tilde{\theta}_{P1}\}} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}} \right) \right] \right] \\
&+ \mathbb{E}_1 \left[\mathbb{1}_{\{h > \tilde{H}\}} \left[\mathbb{1}_{\{\theta_2 \geq \tilde{\theta}_{P2}\}} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}} \right) \right] \right],
\end{aligned}
$$

which is equation (3.23), with complementary slackness conditions:

$$
\begin{aligned}
&\mu \left(-k_2 + \left(\frac{b-f}{c^* \bar{\theta}_2} \right)^{1/\alpha} \right) = 0, \\
&\mu \geq 0, \\
&k_2 \geq \underline{k_2},
\end{aligned}
$$

where the constraint is binding, $k_2 = \underline{k_2}$, when $\mu > 0$.

Similar to the equity maximization with CDS, investment policy is ambiguous and determined by the exogenous level of credit protection h relative to H, which is determined based on firm characteristics, we consider scenarios $h \leq \tilde{H}(k_2)$ and $h > \tilde{H}(k_2)$ separately.

- *When renegotiation is feasible at $t = 2$ ($h \leq \tilde{H}(k_2)$):*

We denote as $\tilde{\Phi}(k_2)$ the marginal benefits of capital in the equity maximization in the presence of the two instruments together and compare it with the marginal benefits of capital when the debt covenant and CDS are used separately, $\Phi_C(k_2)$ (3.26) and $\Phi_S(k_2)$ (3.27), respectively:

$$\tilde{\Phi}(k_2) = \mathbb{E}_1\left[\mathbb{1}_{\{\theta_2<\tilde{\theta}_{P1}\}}\left(\frac{\alpha\theta_2}{(k_2)^{1-\alpha}}\right)(1-\lambda(h)) + \mathbb{1}_{\{\theta_2\geq\tilde{\theta}_{P1}\}}\left(\frac{\alpha\theta_2}{(k_2)^{1-\alpha}}\right)\right] + \mu. \quad (3.29)$$

When the creditor bargaining power is $q = 1$, $\tilde{\theta}_{P1} = \bar{\theta}_P$ and $\lambda(h) = \lambda(h = 0)$, which make $\tilde{\Phi}(k_2)$ identical to the marginal benefits of the equity maximization with the debt covenant: $\tilde{\Phi}(k_2) - \Phi_C(k_2) = 0$. Consequently, $\tilde{k}_2 = k_2^C$.

For the creditor bargaining power $q < 1$, $\tilde{\theta}_{P1} < \bar{\theta}_P$, that implies that for the same capital level $\tilde{\Phi}(k_2) > \Phi_C(k_2)$:

$$\tilde{\Phi}(k_2) - \Phi_C(k_2) = \int_{\tilde{\theta}_{P1}}^{\bar{\theta}_P}\left(\frac{\alpha\theta_2}{k_2^{1-\alpha}}\right)\cdot\lambda(h=0)\,\psi(\theta_2)d\theta_2 > 0,$$

where $\lambda(h = 0) > 0$. Consequently, $\tilde{k}_2 > k_2^C$.

With respect to $\tilde{\Phi}(k_2)$ compared to the marginal benefits of capital with CDS, $\Phi_S(k_2)$, we have:

$$\tilde{\Phi}(k_2) - \Phi_S(k_2) = \int_{\tilde{\theta}_{P1}}^{\hat{\theta}_{P1}}\left(\frac{\alpha\theta_2}{k_2^{1-\alpha}}\right)\cdot\lambda(h)\,\psi(\theta_2)d\theta_2 + \mu \geq 0,$$

where $0 \leq \lambda(h) \leq 1$, $\mu \geq 0$ and the renegotiation thresholds of the two programs can be identical for $f = 0$. Consequently, $\tilde{\Phi}(k_2) \geq \Phi_S(k_2)$ and $\tilde{k}_2 \geq k_2^S$.

Overall, the combination of the debt covenant and CDS together reduces under-investment more than using instruments separately, $k_2^S \leq \tilde{k}_2 \leq k_2^F$ and $k_2^C \leq \tilde{k}_2 \leq k_2^F$.

- *When renegotiation is ruled out at $t = 2$ ($h > \tilde{H}(k_2)$):*

The marginal benefits of capital in the equity maximization with the debt covenant and CDS together are

$$\tilde{\Phi}(k_2) = \mathbb{E}_1\left[\mathbb{1}_{\{\theta_2\geq\tilde{\theta}_{P2}\}}\left(\frac{\alpha\theta_2}{(k_2)^{1-\alpha}}\right)\right] + \mu. \quad (3.30)$$

1. The over-insurance in CDS makes the debt covenant less efficient in mitigating financial agency costs, given $\tilde{k}_2 \leq k_2^C$:

When the creditor bargaining power is $q = 1$, $\tilde{\theta}_{P2} = \bar{\theta}_P$ given that $\lambda(h = 0) = 1$, that makes marginal benefits of the equity maximization in the presence of the two instruments identical to those of with the debt covenant, $\tilde{\Phi}(k_2) = \Phi_C(k_2)$. Consequently, $\tilde{k}_2 = k_2^C$.

When the creditor bargaining power is $q < 1$, the fact that with CDS, on $\theta_2 < \tilde{\theta}_{P2}$, the firm is liquidated and $\tilde{\theta}_{P2} < \bar{\theta}_P$, $0 < \lambda(h = 0) < 1$ implies that $\tilde{\Phi}(k_2) < \Phi_C(k_2)$:

$$\tilde{\Phi}(k_2) - \Phi_C(k_2) = \int_{\tilde{\theta}_{P2}}^{\bar{\theta}_P} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}}\right) \psi(\theta_2)d\theta_2 - \int_0^{\bar{\theta}_P} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}}\right) \cdot (1 - \lambda(h = 0))\, \psi(\theta_2)d\theta_2 < 0.$$

Consequently, $\tilde{k}_2 < k_2^C$.

2. The presence of the debt covenant in the loan agreement makes the underinvestment problem caused by the overinsurance in CDS less severe, given $\tilde{k}_2 \geq k_2^S$:

The comparison of $\tilde{\Phi}(k_2)$ with the marginal benefits of the equity maximization with CDS for the same capital level k_2 implies that $\tilde{\Phi}(k_2) \geq \Phi_S(k_2)$, given $\tilde{\theta}_{P2} \leq \hat{\theta}_{P2}$ and $\mu \geq 0$:

$$\tilde{\Phi}(k_2) - \Phi_S(k_2) = \int_{\tilde{\theta}_{P2}}^{\hat{\theta}_{P2}} \left(\frac{\alpha\theta_2}{k_2^{1-\alpha}}\right) \psi(\theta_2)d\theta_2 + \mu \geq 0,$$

Consequently, $\tilde{k}_2 \geq k_2^S$.

3. In a state of creditors' over-insurance, shareholders underinvest despite the presence of the debt covenant, given $\tilde{k}_2 \leq k_2^E$:

Finally, we compare $\tilde{\Phi}(k_2)$ with $\Phi_E(k_2)$ (with no debt covenants and CDS). The fact that in a state of creditors' over-insurance renegotiation is ruled out and, on $\theta_2 < \tilde{\theta}_{P2}$, the firm is liquidated implies that $\tilde{\Phi}(k_2) \leq \Phi_E(k_2)$. Consequently, $\tilde{k}_2 \leq k_2^E$.

Proposition 3.12

1. The combination of the debt covenant and CDS together is more efficient in reducing the likelihood of strategic default rather than using instruments separately.

Given that the reduction in the likelihood of strategic default manifests itself in the reduction of the renegotiation threshold, we compare the renegotiation threshold $\tilde{\theta}_{P1}$ in the presence of the two instruments together with the renegotiation thresholds when the instruments are used separately ($\bar{\theta}_P$ and $\hat{\theta}_{P1}$ for the models with the covenant and CDS, respectively):

$$\bar{\theta}_P(k_2, b-f) = \frac{b-f}{k_2^\alpha} \cdot \frac{1}{\lambda(h=0)},$$
$$\hat{\theta}_{P1}(k_2,b,h) = \frac{b}{k_2^\alpha} \cdot \frac{(1-h(1-q))}{\lambda(h)},$$
$$\tilde{\theta}_{P1}(k_2,b-f,h) = \frac{b-f}{k_2^\alpha} \cdot \frac{(1-h(1-q))}{\lambda(h)},$$

where $0 \leq \lambda(h) \leq 1$, $0 \leq b-f \leq b$ and $0 \leq 1-h(1-q) \leq 1$ under the initial parameter assumptions.[21]

The comparison of renegotiation thresholds for the same capital level k_2 implies that $\tilde{\theta}_{P1} \leq \bar{\theta}_P$ and $\tilde{\theta}_{P1} \leq \hat{\theta}_{P1}$:

$$\tilde{\theta}_{P1} - \bar{\theta}_P = \frac{b-f}{k_2^\alpha} \cdot \frac{-h(1-q)}{\lambda(h)} \leq 0;$$
$$\tilde{\theta}_{P1} - \hat{\theta}_{P1} = \frac{-f}{k_2^\alpha} \cdot \frac{1-h(1-q)}{\lambda(h)} \leq 0.$$

Note, the sign between thresholds $\hat{\theta}_P$ (either $\hat{\theta}_{P1}$ or $\hat{\theta}_{P2}$) of the equity maximization with CDS and $\bar{\theta}_P$ of the covenant constrained equity maximization depends on the size of anticipation payment f ensuring the covenant compliance, the creditor bargaining power q and the level of credit protection h:

$$\bar{\theta}_P - \hat{\theta}_{P1} = \frac{-f + h(1-q)}{k_2^\alpha \lambda(h)},$$
$$\bar{\theta}_P - \hat{\theta}_{P2} = \frac{b(1-\lambda(h=0)) - f}{k_2^\alpha \lambda(h=0)}.$$

2. The presence of the debt covenant allows to reduce the probability of inefficient liquidation caused by CDS-protected empty creditors, i.e. for $h > \tilde{H}(\theta_2,\tilde{k}_2)$.

We compare the default threshold $\tilde{\theta}_{P2}$ in the presence of the debt covenant and CDS together against the default threshold $\hat{\theta}_{P2}$ with just CDS for the same capital level k_2:

$$\tilde{\theta}_{P2} - \hat{\theta}_{P2} = \frac{-f}{k_2^\alpha} \leq 0,$$

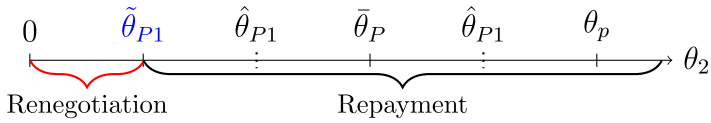
[21] In the covenant constrained equity maximization, $0 < \lambda(h) \leq 1$ given that $h = 0$.

where

$$\hat{\theta}_{P2}(k_2,b) = \frac{b}{k_2^{\alpha}},$$
$$\tilde{\theta}_{P2}(k_2,b-f) = \frac{b-f}{k_2^{\alpha}}.$$

Taken together, we summarize the comparison of optimal renegotiation decisions of the unconstrained versus the constrained equity maximization (with the debt covenant and CDS used as separate tools and together) in Figure 3.5.

(a) $0 < h \leq H(\theta_2,k_2,b)$



(b) $h > H(\theta_2,k_2,b)$

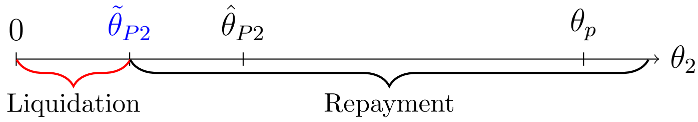


Figure 3.5: **Optimal renegotiation/repayment decision: unconstrained vs. constrained equity maximization.** The figure presents the optimal equity holders' renegotiation/repayment decision as a function of θ_2 for two scenarios of creditors' hedge ratio h. In Panel A, the shareholders optimally decide to repay the debt in full when θ_2 is above a renegotiation threshold and to renegotiate when it is below. In Panel B, renegotiation is ruled out, and the debt is repaid when θ_2 is above a default threshold and the firm is liquidated when it is below. Unconstrained equity maximization (with no debt covenant and CDS) is represented by the renegotiation threshold θ_P, Covenant constrained equity maximization is represented by $\bar{\theta}_P$, equity maximization with CDS is represented by $\hat{\theta}_{P1}$ and $\hat{\theta}_{P2}$, and Covenant-CDS constrained equity maximization is represented by $\tilde{\theta}_{P1}$ and $\tilde{\theta}_{P2}$.

Appendix B. Additional properties of the model with CDS trading

B.1. The debt holders' payoff and the price of credit protection

Given the creditors' hedge ratio h and the optimal default decision of the shareholders described in equation (3.17) in Section 3.4.2, the debt holders' payoff at $t = 2$ is

$$\begin{aligned}\phi(\theta_2,k_2,b,h) = \mathbb{1}_{\{h\leq H\}}\left[\mathbb{1}_{\{\theta_2<\hat{\theta}_{P1}\}}\hat{b}_r(\theta_2,k_2,b,h) + \mathbb{1}_{\{\theta_2\geq\hat{\theta}_{P1}\}}b\right]\\ + \mathbb{1}_{\{h>H\}}\left[\mathbb{1}_{\{\theta_2<\hat{\theta}_{P2}\}}\Pi(\theta_2,k_2,b,h) + \mathbb{1}_{\{\theta_2\geq\hat{\theta}_{P2}\}}b\right],\end{aligned}$$

where $\mathbb{1}_{\{h>H\}}$ is the "empty creditor" indicator, i.e. when renegotiation is never achievable.

The debt value at $t = 0$ is then calculated as the difference between the expected creditors' payoff $\phi(\theta_0,k_0,b,h)$ and the insurance premium $\gamma(\theta_0,k_0,b,h)$ paid at the end of the contract:[22]

$$\begin{aligned}\hat{D}(\theta_0,k_0,b,h) &= \int \mathbb{1}_{\{h\leq H\}}\left[\int_0^{\hat{\theta}_{P1}(k_2)} \hat{b}_r(\theta_2,k_2,b,h)\,\psi(\theta_2)d\theta_2 + b(1-\psi(\hat{\theta}_{P1}))\right]\psi(\theta_1)d\theta_1\\ &+ \int \mathbb{1}_{\{h>H\}}\left[\int_0^{\hat{\theta}_{P2}} \Pi(\theta_2,k_2,b,h)\,\psi(\theta_2)d\theta_2 + b(1-\psi(\hat{\theta}_{P2}))\right]\psi(\theta_1)d\theta_1 - \gamma(\theta_0,k_0,b,h)\\ &= \int \mathbb{1}_{\{h\leq H\}}\left[\int_0^{\hat{\theta}_{P1}(k_2)} \hat{b}_r(\theta_2,k_2,b,h)\,\psi(\theta_2)d\theta_2 + b(1-\psi(\hat{\theta}_{P1}))\right]\psi(\theta_1)d\theta_1\\ &+ \int \mathbb{1}_{\{h>H\}}\left[\int_0^{\hat{\theta}_{P2}} \ell\theta_2k_2\,\psi(\theta_2)d\theta_2 + b(1-\psi(\hat{\theta}_{P2}))\right]\psi(\theta_1)d\theta_1,\end{aligned}$$

where the price of credit protection $\gamma(\theta_0,k_0,b,h)$ is calculated as the expectation of the net compensation from the CDS seller:

$$\gamma(\theta_0,k_0,b,h) = \int \mathbb{1}_{\{h>H\}}\left[\int_0^{\hat{\theta}_{P2}} (hb - h\ell\theta_2k_2)\,\psi(\theta_2)d\theta_2\right]\psi(\theta_1)d\theta_1.$$

[22]While h is maintained constant and the CDS contract issued at $t = 0$ is not renegotiated over the life of the contract, we assume the the price paid ex post is consistent with the actual firm's risk given the protection buyer's opportunity to sell/buy new contracts over time.

Chapter 4

Credit Default Swaps and Financial Contracting: Empirical Evidence

4.1. Introduction

It has long been argued, back to Jensen and Meckling (1976), Myers (1977) and Hart and Moore (1989, 1994), that the use of debt financing might introduce misalignment of the incentives of debt and equity. Specifically, the corporate finance literature indicates that the lack of commitment of equity holders to repay a debt and/or implement value maximizing corporate policies results in lenders' wealth expropriation. The magnitude of these agency costs reveals the increasing importance to derive optimal mechanisms allowing to alleviate the costs of no-commitment.[1]

Debt covenants, along with other specific provisions in a debt contract (e.g., maturity, seniority structure), are generally viewed as a traditional value enhancing tool of financial contracting, that allows to reduce the costs of no-commitment through disciplining and determining the set of policies that shareholders are committing to. The literature indicates both ex post and ex ante effects of debt covenants on borrower corporate policies. The ex post effects arise from debt covenants' ability to

[1] How large the effect of agency costs has been studied in various settings by Hennessy (2004), Moyen (2007), Titman and Tsyplakov (2007), DeMarzo (2019) and Gamba and Saretto (2019). For instance, on the example of the cost of debt, Gamba and Saretto (2019) demonstrate that agency costs (such as debt claim dilution, underinvestment, and asset stripping) represent approximately 39% of the average credit spread.

allocate control rights between contracting parties on a state-contingent manner, i.e. that allows debt holders to get control rights and influence firm policies at covenant violations (e.g., see Chava and Roberts, 2008; Nini, Smith, and Sufi, 2009). In contrast, the ex ante effects arise from the increased shareholders' motivation to adjust their policies ex ante to reduce the likelihood of triggering a covenant violation and ensure the covenant compliance (e.g., see Gamba and Triantis, 2014; Xiang, 2019). Notably, Gamba and Triantis (2014) emphasize that much of the effect of covenant restrictions on corporate policies occurs ex ante, away from its violation points. All together, these views underline the role of debt covenants as an important tool of financial contacting intended to increase shareholders' commitment ex post.

The rise of the CDS market, one of the major financial innovations of recent decades, has created a new commitment device for borrowers to repay their obligations. Redistribution of bargaining power in favour of creditors following the introduction of CDS trading reduces an incidence of strategic default by making debt renegotiation more difficult. CDS-protected creditors have an incentive to impose harsher loan terms during debt renegotiation or, in a case of creditors' over-insurance, to push borrowers into bankruptcy (as an "empty creditor") following the non-payment of debt (e.g., see Bolton and Oehmke, 2011; Danis and Gamba, 2018; Kim, 2016). Based on the findings of weakened financial covenant strictness and collateral requirements in newly issued private loans of CDS-traded firms, the recent empirical study of Shan, Tang, and Winton (2019) suggests that CDSs improve contracting efficiency by substituting loan contractual protection.

Has the emergence of the CDS market affected creditors' incentive to use traditional tools of financial contracting, such as debt covenants, for protection of their interests? In other words, does the availability of a new commitment mechanism, significantly strengthening bargaining power of creditors, reduce creditors' incentive to use covenants? Differently from the study of Shan, Tang, and Winton (2019), to address these questions, we propose a direct test on the ability of CDS contracts to be used as an adequate substitute for financial covenants.[2] In addition, we examine any complementary (or detrimental) value that the presence of CDS trading can bring to debt covenant effectiveness.

[2]While Shan, Tang, and Winton (2019) explain the possible substitutive effect of CDSs by potential reduction in creditors' incentive to monitor, we directly test whether CDSs are able to solve problems that are typically addressed by covenants. Note that, in terms of covenants, monitoring is just an instrument helping to identify the need of value improving renegotiation based on technical default and facilitate ex post effect of covenants on corporate policies. However, the rationale for covenants in loan agreements is much broader.

Our main hypotheses are based on the model's predictions developed in Chapter 3, that represents a first theoretical study analysing the effect of CDSs on financial contracting via its impact on debt covenants. By considering in details the rationality for creditors to use CDSs and debt covenants as individual commitment mechanisms and in combination, the model helps to understand if the presence of one instrument changes the rationality and incentives for creditors to use the other. In particular, the theory indicates that CDSs and covenants share the ability to increase debt protection by reducing the likelihood of strategic debt service. However, it is not clear a priori whether these two instruments are equally effective in reducing costs arising from no-commitment to implement value maximizing corporate policies.

We build an extensive dataset covering financial information of U.S. public firms over the period 1994 to 2016, their CDS trades, including information on CDS trade initiation and net notional amount of CDS outstanding, and private loans issued by bank and non-bank lenders. Based on this data, we construct a comprehensive measure of loan-level financial covenant strictness following a non-parametric simulation approach of Demerjian and Owens (2016), who proposed an alternative and more flexible method to the parametric simulation approach developed by Murfin (2012).

To test whether CDSs can substitute covenants in loan contracts, we concentrate on potential distinctive characteristics of these two commitment mechanisms, and examine whether CDSs are equally effective in alleviating distortions of the optimal investment policy as financial covenants. We rely on the existing literature of empirical investment models considering debt overhang problem, one of the central focus of the financial agency literature, posited by Myers (1977). Specifically, we follow Hennessy (2004), Hennessy, Levy, and Whited (2007) and construct an empirical proxy of a debt overhang wedge correction which is intended to capture investment return accruing to debt holders as opposed to equity holders. The above measure is built on theoretical predictions indicating the more severe overhang and, as a result, underinvestment for firms with high leverage, high default probabilities, and high lenders' recovery ratios in default. The interaction of the debt overhang empirical measure with the commitment mechanisms of the interest allows us to test individual and joint effects of CDSs and financial covenants on the investment distortions caused by debt overhang.

Our baseline results provide strong empirical support for the comparative statics predictions developed in Chapter 3. We find that the investment-distortion effect of CDSs dominates. In other words, the negative investment effect of debt overhang is amplified after the introduction of CDS trading on firm debt. Furthermore, the investment-distortion effect of CDSs is more prominent for firms with the higher probability that creditors turn into empty creditors and force a liquidation, such as for the higher amount of CDS insurance written on firms and/or the weaker firms' fundamentals. In contrast, stricter financial covenants restore investment incentive reduced by debt overhang. However, in the post - CDS inception, covenants lose their effectiveness as a mechanism intended to reduce investment agency distortions. The CDS market undermines shareholders' incentive to undertake valuable investment despite the presence of strict financial covenants in a loan contract.

In our empirical analysis, we address potential endogeneity concerns with respect to both the timing of CDS introduction and the financial covenant strictness, which is heavily dependent on borrowers' financial characteristics. First, we follow Danis (2016) and Colonnello, Efing, and Zucchi (2019), and conduct a quasi-natural experiment in a narrow window period around the implementation of the CDS Big Bang Protocol on April 4, 2009. There are several reasons to believe that this regulatory reform might affect the severity of the empty creditor problem. Particularly, it facilitated an improvement of liquidity and availability of CDSs, that in turn increased attractiveness of credit risk hedging. Furthermore, it excluded debt restructuring from eligible credit events, thereby reducing lenders' incentive to restructure debt out of court and making lenders tougher in debt renegotiation. Consistent with our theoretical predictions (i.e., the stronger CDS-induced debt overhang for the greater empty creditor threat), we find that firms with outstanding CDSs forgo value-increasing investment during the first six calendar quarters after the Big Bang Protocol introduction, despite the presence of strict covenants in debt contracts.

Next, we show that our measure of covenant strictness is endogenous because at the loan inception it is determined based on borrowers' financial characteristics together with contracting choices. As a result, the estimation coefficients are biased in the presence of simultaneity.[3] We address this endogeneity issue using a two-stage instrumental variable (IV) approach with the number of loan defaults suffered by the lead lender prior contracting a new loan as an instrument. The instrument choice is based on the findings of Murfin (2012), who shows that banks' exposure to idiosyncratic risk, such as payment defaults to their own loan portfolios, induces lenders to tighten provisions in their new loan contracts. Thus, the current instrument choice allows us to concentrate on unrelated to borrowers' characteristics determinants of covenant strictness, that take into account supply (lender) - side effects.

[3]Similarly, in the analysis of the effect of covenants on firm operating performance, Spyridopoulos (2019) provides evidence that the estimated coefficient of covenants strictness based on OLS regressions is negatively biased and requires endogeneity addressing.

In addition, we perform various checks and confirm that our findings are robust to alternative measures of the likelihood of the empty creditor threat. Specifically, we provide an additional analysis on cross-sectional heterogeneity in our baseline results based on the likelihood of firms to face empty creditors. We find that CDS trading enhances debt overhang problem and makes debt covenants less effective in the subsamples of firms with higher risk, characterized by high firm leverage, high cash flow volatility, and a long-term debt rating below investment grade. These results support our arguments that weaker fundamentals make firms more vulnerable to the empty creditor threat. Furthermore, we explore heterogeneity in our results through identification of types of firms for which creditors have higher tendency to over-insure. We find that CDSs lead to underinvestment and covenant effectiveness loss in subsamples characterized by high shareholders' bargaining power, low renegotiation frictions, and high liquidations costs. The current literature on CDSs indicates that these characteristics are associated with the tendency of lenders, who are more vulnerable to the strategic default threat, to choose a higher hedge ratio in the CDS market in order to enhance commitment benefits (e.g., see Colonnello, Efing, and Zucchi, 2019; Danis and Gamba, 2018; Wong and Yu, 2018).

Further, our results are not sensitive to potential measurement errors associated with the inclusion of proxies for unobservable variables, such as marginal q and debt overhang. The results remain qualitatively unchanged to using the higher-order cumulant estimators of Erickson, Jiang, and Whited (2014). In addition, our findings are robust to an alternative measure of underinvestment. As a robustness check, we follow the extant literature in accounting and construct a measure of investment inefficiency by modelling the expected optimal level of firm-specific capital investment based on a neoclassical parsimonious model of firm growth opportunities (e.g., see Biddle, Hilary, and Verdi, 2009; Chen, Hope, Li, and Wang, 2011). Specifically, we use residuals of the investment model to determine deviations from the expected optimal level. Where a negative residual (i.e., a negative deviation from the expected investment) indicates underinvestment, a form of investment inefficiency when a firm makes investment at a lower rate than the expected level.

Our empirical study contributes to several streams of the literature. First, our study adds to the literature analysing the improvement of contracting efficiency through commitment. We extend this literature by showing that CDSs, though bringing ex ante commitment benefits through reducing the incidence of strategic default, cannot completely replace a traditional tool of financial contracting, such as debt covenants. In addition, despite that covenants have long been considered by theorists as a countervailing force against known agency conflicts, our work provides the first direct empirical test on their ability to mitigate debt overhang problem. Finally, we show that combining two commitment mechanisms together can negatively affect the effectiveness of one of the instruments.

Second, our study contributes to the ongoing debate on the costs and benefits of CDS trading. On the one hand, previous studies have shown that the introduction of CDS trading allows financially constrained firms to receive ex-ante financing for a larger set of positive NPV projects (e.g., Bolton and Oehmke, 2011; Danis and Gamba, 2018). On the other hand, we demonstrate the value-reducing effect of CDSs through the amplification of the negative investment effect of debt overhang in firms that are more likely to be affected by the empty creditor problem. This empirical finding is in support of theoretical predictions of Wong and Yu (2018).

Third, our study shows a new effect of CDS trading on covenants, which has been overlooked in the literature. We show that following the onset of CDS trading, an exogenous increase in covenant tightness no longer helps to alleviate the debt overhang problem. These findings are not inconsistent with Shan, Tang, and Winton (2019) or with other empirical papers on covenants and CDSs, but they provide a new explanation for why covenants have become looser following CDS trading. Covenants are costly because they constrain a firm's behavior. If they are not useful in addressing the debt overhang problem after the introduction of CDSs, then it makes sense for the firm and the lender to negotiate looser covenants at loan inception.

Finally, we contribute to the literature indicating ex ante covenant effects on borrower corporate policies, i.e. upon violations of covenant restrictions. The vast empirical literature concentrates mainly on the states around covenant violation by demonstrating creditor interventions in borrower policies as a result of renegotiation caused by a technical default (e.g., Chava and Roberts, 2008; Nini, Smith, and Sufi, 2009). Exceptions are Demiroglu and James (2010) and Spyridopoulos (2019), who demonstrate that stricter loan covenants affect corporate policies, and are associated with an increase in profitability even when firms do not breach their covenants.

The remainder of the chapter is organized as follows. Section 4.2 summarizes testable hypotheses based on the theoretical predictions in Chapter 3. Section 4.3 describes the empirical framework we use to test the key predictions and address potential endogeneity concerns. Section 4.4 describes the data, and the construction of samples and variables. Sections 4.5 and 4.6 provide baseline empirical results and additional robustness check, respectively. Section 4.7 concludes the chapter.

4.2. Empirical Predictions

The theoretical model in Chapter 3 allows to compare the effectiveness of debt covenants and CDSs as commitment mechanisms (i.e., through investigating the ability of either tool to alleviate the costs of no-commitment that are naturally addressed by the other instrument), and determine whether the presence of one instrument affects the effectiveness of another in the joint use.

In particular, the model focuses on two types of costs arising from shareholders' lack of commitment: investment-related agency costs and strategic default. As investment-related agency costs, we consider investment distortions caused by debt overhang, which is one of the foci of the financial agency literature. As it is known from Myers (1977), the fact that shareholders invest to maximize equity value leads to a situation when the presence of outstanding (risky) debt reduces shareholders' incentive to undertake value-increasing investment because the benefit of such investment would accrue to the existing debt holders. The underinvestment problem caused by debt overhang has been also confirmed by more recent theoretical and empirical studies (e.g., see Alanis, Chava, and Kumar, 2018; Hennessy, 2004; Hennessy, Levy, and Whited, 2007). Hennessy (2004) also demonstrates that debt overhang distorts not just the level of investment, but also its composition, while the economic significance of the overhang channel is more significant for firms in distress. Recently, DeMarzo and He (2017), and Admati, DeMarzo, Hellwig, and Pfleiderer (2018) identify a new type of agency conflict "leverage ratchet effect", which represents the impact of debt overhang on firm leverage policy. Gamba and Saretto (2019) show that the "leverage ratchet effect" is quantitatively at least as important in transferring wealth from debt to equity as underinvestment due to debt overhang.

Our theoretical model predicts that while both commitment mechanisms are effective in reducing shareholders' incentive to default strategically, they are not equally effective in alleviating underinvestment. Specifically, we provide an additional theoretical confirmation on the ability of covenants to restore investment incentive reduced by debt overhang. The stricter the covenants, the lower the negative effect of debt overhang on investment policy. In contrast, we find that the effect of CDS trading on underinvestment is ambiguous, and it can both alleviate or exacerbate the debt overhang problem (see, Proposition 3.10). The model identifies two mechanisms through which CDSs influence investment distortions caused by debt overhang, with the outcomes depending on the likelihood of borrowers to be affected by the empty creditor problem. Whereas the probability of lenders to turn into inefficient empty creditors in default state, i.e. into creditors who always prefer to force a borrower into bankruptcy, increases with the borrower risk and the amount of CDS insurance written on firms.

When the probability that creditors turn into empty creditors and force a liquidation is low, CDSs reduce the negative effect of debt overhang on firm investment policy due to increasing renegotiation frictions and the subsequent reduction of the occurrence of strategic default. That is in line with the theoretical study of Pawlina (2010), who provides evidence that the possibility of debt renegotiation upon financial distress (and, as a result, the possibility of strategic default) exacerbates the underinvestment problem. He also suggests that the debt overhang might be reduced by higher renegotiation frictions such as in public debt, for which disperse debt holding increases coordination costs and makes renegotiation prohibitively expensive (Rajan, 1992), and/or in legal systems with strong enforcement of creditors' rights (Favara, Schroth, and Valta, 2012). On the contrary, when there is a high risk for borrowers to be affected by the empty creditor problem, shareholders, fearing forceful liquidation caused by empty creditors and sharing the return of equity-financed investment with debt holders in default, will pass up valuable investment opportunities. The debt overhang exacerbation is also consistent with the recent theoretical study of Wong and Yu (2018), who by introducing a Leland's (1994) type model with dynamic investment opportunities show that CDSs drive debt overhang through the empty creditor channel.

In addition to the ambiguous effect of CDSs on underinvestment, our theoretical model predicts that the presence of CDS trading might affect the effectiveness of debt covenants as a commitment mechanism (see, Proposition 3.11). Particularly, CDSs make covenants more effective when value-enhancing effect of CDSs dominates (i.e., when the alleviation of debt overhang problem is feasible owing to increased renegotiation frictions). That is in line with findings of the theoretical study of Gamba and Mao (2019), who demonstrate that the presence of frictions limiting ex post debt renegotiation is essential to make covenants an useful commitment device. In contrast, when value-reducing effect of CDSs dominates (i.e., when CDSs worsen debt overhang due to high empty creditor threat), the higher likelihood of liquidation with no chance to renegotiate debt make covenants ineffective in mitigating underinvestment.[4] As a result, the firm underinvests despite the presence of covenants in a loan agreement.

[4]Notably, even though the presence of covenants in a credit agreement allows to reduce the likelihood of inefficient liquidation caused by CDS-protected empty creditors, debt covenants prove ineffective in reducing investment distortions caused by debt overhang.

In the subsequent sections, we focus on potential distinctive characteristics of the two commitment mechanisms, and conduct the empirical analysis on their ability to affect investment distortions caused by debt overhang. The testable hypotheses are formulated based on our theoretical predictions discussed above, under the assumption of an exogenous lender's hedge ratio in the CDS market.

Hypothesis 1 (Covenants and debt overhang)**.** *The negative effect of debt overhang on borrower investment policy decreases with the strictness of debt covenants.*

Hypothesis 2 (CDS and debt overhang)**.** *When the threat of empty creditor problem is low (high), the CDS market reduces (exacerbates) the debt overhang issue.*

Hypothesis 3 (Joint effect of covenants and CDS on debt overhang)**.** *When the threat of empty creditor problem is low (high), the CDS market makes debt covenants more (less) effective as a commitment mechanism.*

4.3. Research Design

This section describes the empirical framework we use to test the key predictions of the model. To test whether CDS trading can be used as an adequate substitute for covenants in loan contracts, we start from individual tests on the ability of CDSs and financial covenants to reduce underinvestment caused by debt overhang (Hypotheses 1 and 2). These tests serve as a starting point for the empirical design and logic of the test on changes in covenant effectiveness following the introduction of CDS trading (Hypothesis 3).

4.3.1. Empirical specification

To derive a baseline empirical specification, we rely on the existing empirical literature on investments that consider debt overhang problem posited by Myers (1977). Specifically, we follow Hennessy (2004), Hennessy, Levy, and Whited (2007) and include an empirical proxy of debt overhang ($Overhang$) which is intended to catch up investment returns accruing to debt holders as opposed to equity holders:

$$Investment_{i,t} = \beta_0 + \beta_1\, Overhang_{i,t-1} + \beta_2\, Cash\,Flow_{i,t} + \beta_3\, TobinQ_{i,t-1} + \epsilon_{i,t}, \quad (4.1)$$

where the subscripts i and t indicate a firm and a fiscal quarter, respectively. The dependent variable of interest is $Investment_{i,t}$, defined as the rate of investment expenditures normalized by the start-of-period capital stock (i.e., at $t-1$). As is standard in the literature, we control for the principal determinants in empirical investment models such as the cash flow generated during the fiscal quarter t and scaled by the start-of-period capital stock, and the start-of period Tobin's Q.[5] The model is estimated using firm and time (calendar quarter - year) fixed effects. Standard errors are robust to heteroskedasticity and clustered at the firm level.

Consistent to Myers's theory and the supportive empirical evidence, the expected coefficient sign for *Overhang* is negative. In particular, equity-maximizing shareholders underinvest relative to first-best whenever future investment returns give a positive spillover to lenders who could recover the assets of the firm in bankruptcy. The higher debt overhang correction, the more severe underinvestment problem, resulting in the negative impact on investment.

Next, to test our key empirical predictions, we enhance the model design in (4.1) by including a commitment mechanism of the interest (either CDS contracts, or financial covenants). Specifically, we test the effect of a commitment mechanism on underinvestment caused by debt overhang through an interaction of a commitment mechanism, *Commit Mechanism*, with the debt overhang, *Overhang*. Alanis, Chava, and Kumar (2018) use the similar specification in their analysis of the impact of shareholder bargaining power on the investment effects of debt overhang.

$$\begin{aligned} Investment_{i,t} = \beta_0 &+ \beta_1\, Overhang_{i,t-1} \times Commit\, Mechanism_{i,t-1} \\ &+ \beta_2\, Overhang_{i,t-1} + \beta_3\, Commit\, Mechanism_{i,t-1} \\ &+ \beta_4\, Cash\, Flow_{i,t} + \beta_5\, TobinQ_{i,t-1} + \epsilon_{i,t}, \end{aligned} \tag{4.2}$$

where *Commit Mechanism* defines either as an indicator of CDS trading activity (*CDS Active*), or an aggregated measure of strictness of financial covenants (*FinCov*) included in a loan at the loan inception. The positive (negative) sign of the interaction *Overhang* $\times$ *Commit Mechanism* indicates the mitigation (exacerbation) of underinvestment caused by debt overhang. Consistent with the theoretical predictions, we expect the lower impact of debt overhang on investment for tighter debt covenants, that should result in the positive interaction term, $\beta_1 > 0$. With respect to CDSs, the model predicts an ambiguous effect on underinvestment, conditional on the likelihood of the empty creditor threat.

To test the potential heterogeneity in the CDS effect on investment distortions

[5] For instance, see Alanis, Chava, and Kumar (2018); Hennessy (2004); Hennessy, Levy, and Whited (2007).

caused by debt overhang, we first replace the binary variable *CDS Active* with the continuous variable *Hedge Ratio*, which represents an aggregate hedge ratio of lenders for a particular borrower in the CDS market and corresponds to the parameter h in our model.[6] The higher the amount of CDS insurance written on firms, the greater the empty creditor threat. Next, we measure borrowers' propensity to be affected by the empty creditor problem based on firm financial stability, *Firm Stability*, that closely corresponds to the model's parameter H. The weaker firms' fundamentals, the more attractive bankruptcy option to lenders even in the absence of creditors' over-insurance (i.e, even for the moderate level of credit protection h). According to this statement, we split the sample into firms with low and high firm stability. We discuss the construction of all key variables in detail in Section 4.4.

Finally, we test the joint effect of covenants and CDSs on the investment effect of debt overhang. To do it, we modify equation (4.2) to consider two commitment mechanisms at the same time. Similarly to the test on the individual effect of CDSs on debt overhang problem, we take into account the potential heterogeneity in our results, conditional on the likelihood of the empty creditor threat. Specifically, we estimate the following regression:

$$\begin{aligned} Investment_{i,t} = \beta_0 &+ \beta_1\, Overhang_{i,t-1} \times FinCov_{i,t-1} \times CDS\,Active_{i,t-1} \\ &+ \beta_2\, Overhang_{i,t-1} \times Commit\,Mechanism^*_{i,t-1} \\ &+ \beta_3\, Overhang_{i,t-1} \\ &+ \beta_4\, CDS\,Active_{i,t-1} \times FinCov_{i,t-1} \\ &+ \beta_5\, Commit\,Mechanism^*_{i,t-1} \\ &+ \beta_6\, Cash\,Flow_{i,t} + \beta_7\, TobinQ_{i,t-1} + \epsilon_{i,t}, \end{aligned} \tag{4.3}$$

where $Commit\,Mechanism^*$ defines either an indicator of CDS trading activity ($CDS\,Active$), or an aggregated measure of strictness of financial covenants ($FinCov$) included in a loan at the loan inception.[7] The interaction term $Overhang \times FinCov \times CDS\,Active$ is a variable of interest, which examines any changes in covenant effectiveness to mitigate underinvestment caused by debt overhang post CDS inception. The positive (negative) sign of the interaction indicates the enhanced (reduced) ability

[6]The model indicates that the probability of lenders to turn into inefficient empty creditors in default state depends on the two model's parameters: lenders' hedge ratio h and the parameter H representing firm financial stability. In particular, the probability increases with the amount of CDS insurance written on firms and the borrower risk.

[7]A simultaneous examination of two instruments produces two interaction terms for $Overhang \times Commit\,Mechanism^*$, such as $Overhang \times CDS\,Active$ and $Overhang \times FinCov$, and two variables for $Commit\,Mechanism^*$, such as $CDS\,Active$ and $FinCov$.

of covenants as a mechanism against no-commitment post CDS inception.

4.3.2. Potential endogeneity concerns

In the following section, we suggest econometric methodologies to address potential endogeneity concerns with respect to both the timing of CDS introduction and the financial covenant strictness, which is heavily dependent on borrowers' financial characteristics.

Endogeneity of debt covenant strictness

Using the empirical specification described above, we should be particularly careful in estimating the effect of debt covenant strictness on firm investment policy. Our measure of covenant strictness is potentially endogenous because at the loan inception it is determined based on borrowers' financial characteristics together with contracting choices. As a result, the estimation coefficients in equations (4.2) - (4.3) might be biased in the presence of simultaneity.

To address potential endogeneity, we apply a two-stage instrumental variable (IV) approach. In identification of a valid instrument for the endogenous regressor, *FinCov*, we follow Roberts and Whited (2012) and look for a variable that satisfies two conditions, relevance condition (i.e., the instrument has partial correlation with the debt covenant strictness) and exclusion condition (i.e., the instrument affects borrower's investment policy just through its effect on the covenant strictness). Unlike the relevance condition, the exclusion condition is more challenging because of the requirement to define determinants of covenant strictness, which are unrelated to borrowers' characteristics. Consequently, to satisfy the exclusion condition, we concentrate on determinants of covenants strictness based on the supply (lender) - side characteristics. Murfin (2012) was the first who provide evidence of the importance of lender-specific shocks for the strictness of loan contracts.[8] Specifically, he shows that banks' exposure to idiosyncratic risk, such as payment defaults to their own loan portfolios, induces lenders to tighten covenant provisions in their new loan contracts.

[8]The relation between lenders' loan portfolio performance (e.g., recent default experience) and lender behaviour has been indicated in a number of studies. For instance, Chava and Purnanandam (2011) show that banks affected by the 1998 Russian sovereign default subsequently decreased the quantity of their lending and increased loan interest rates. Gopalan, Nanda, and Yerramilli (2011) provide evidence that large-scale bankruptcies among borrowers affect subsequent activity of lead arrangers in the syndicated loan market.

Motivated by the findings of Murfin (2012), we construct the instrumental variable based on the number of loan defaults suffered by the lead lender during the 360 day period prior contracting a new loan. Specifically, for each new loan contract, we count number of defaults for outstanding loans in portfolios of the lead arrangers prior its issuance. As a default, we consider the moment when a borrower's S&P long-term debt rating changes to default (D) or selective default (SD). This classification allows to capture economically significant defaults that represent payment defaults on at least one obligation.

In the spirit of Murfin (2012), we define a contracting date for a new loan as 90 days prior to the loan start date (i.e., the legal effective date). The adjustment is motivated in the interest of realism to account for the time lag between contracting (negotiation of loan terms) and closing. In the real world, an average syndicated transaction takes around two months for the documentation process, between the date of receiving a mandate from the borrower and the legal effective date of the loan. Whereas the pre-mandate phase, including negotiation of loan terms and approving a term sheet, takes at least a month (e.g., see Campbell, Rhodes, Weaver, Bailey, and Andrews, 2013).

The constructed instrument is then used in the first stage of the two-stage-least-squares (2SLS) regression, which estimates the aggregated strictness of financial covenants included in the loan:

$$FinCov_{i,t} = \beta_0 + \beta_1\, Default\, N\, days_{i,t} + \beta_2\, X_{i,t} + \epsilon_{i,t}, \tag{4.4}$$

where the subscripts i and t indicate a borrower and a fiscal quarter (time of loan issuance), respectively. *Default N days* is the number of outstanding loan packages in the loan portfolio of the lead lender that defaulted N days prior contracting of a new loan, where N days ranges 0 - 360 days before contracting. We break down defaults for different time periods to define for which one banks are more sensitive in their contracting decisions. X represents an array of borrowing firms' characteristics capturing observable proxies for credit risk (such as, a dummy variable for S&P long-term credit rating, and Altman Z-score), and loan characteristics (such as the loan package maturity, the loan package amount, the number of bank participants, the number of lead arrangers). As previously, the model is estimated using firm and time (calendar quarter - year) fixed effects. In addition, we include the lender fixed effects to remove possible effects of lenders' size, that might influence the number of defaults in lenders' portfolios and their specific contracting propensities.

The fitted value of the covenant strictness, $\underline{FinCov}$, is used next for the second-stage estimation based on the empirical design of equations (4.2) - (4.3).

Endogeneity of CDS trading

To address potential endogeneity issues associated with timing of the introduction of CDS trading, we follow Danis (2016) and Colonnello, Efing, and Zucchi (2019), and examine the implementation of the CDS Big Bang Protocol on April 4, 2009 as a quasi-natural experiment affecting the severity of the empty creditor problem. Theoretically, we expect that the higher empty creditor threat post CDS inception reduces equity holders' incentive to undertake valuable investment by exacerbating debt overhang problem. Consequently, we expect a negative exogenous shock generated by the CDS Big Bang to the borrower's investment policy and the covenant effectiveness in the presence of CDS trading.

There are several reasons to believe that the CDS Big Bang might affect the likelihood of the empty creditor problem. First, a harmonization of contract terms within the CDS Big Bang facilitates the improvement of liquidity and availability of CDSs, that in turn increase attractiveness of credit risk hedging (for more details on changes in contract terms of CDS contracts, see Markit, 2009). Colonnello, Efing, and Zucchi (2019) find confirmation of a statistically significant increase in CDS liquidity following the implementation of the CDS Big Bang Protocol. Furthermore, the CDS Big Bang Protocol redefined the definitions of eligible credit events of North American CDS contracts. Specifically, it excluded the most common type of clauses in CDS contracts, out-of-court debt restructuring (named as "Modified Restructuring (MR)"), from credit events. As a result, the CDS Big Bang leads to exacerbation of renegotiation frictions for CDS traded firms through reducing lenders' incentive to restructure debt out of court.

To conduct a quasi-natural experiment for the baseline empirical specification, we apply a difference-in-difference approach by restricting the sample to the six calendar quarters before and the six calendar quarters after the CDS Big Bang Protocol. We define *PostBigBang* as an indicator variable of the post-event period (i.e., after April 4, 2009). Whereas treated firms are defined as those with CDS trading on their debt (denoted as *CDS Firm*) at any time during the total sample period for the empirical specification in (2), and as CDS-traded firms with strict financial covenants, $CDS\,Firm \times FinCov$, for the empirical specification in (3). Given that the main purpose of the analysis is to examine individual and join effects of commitment mechanisms on underinvestment caused by debt overhang, $Overhang \times CDS\, Firm \times PostBigBang$ and $Overhang \times FinCov \times CDS\, Firm \times PostBigBang$ are the main variables of interests for the empirical specifications in (4.2) and (4.3), respectively.

4.4. Data Sources and Variable Construction

This section describes the data and construction of key variables used in the analysis.

4.4.1. Empirical measures

Debt overhang

Our empirical measure of debt overhang is constructed in the spirit of the extant literature (e.g., Hennessy, 2004, Hennessy, Levy, and Whited, 2007, and Alanis, Chava, and Kumar, 2018) by substituting quarterly data for annual data. The measure is robust to measurement error and built on theoretical predictions indicating the more severe overhang for firm with high leverage, high default probabilities, and high lenders' recovery ratios in default. Intuitively, it is intended to capture investment return accruing to debt holders as opposed to equity holders. That undermines a shareholders' incentive to undertake valuable investment. The higher debt overhang measure, the more severe underinvestment problem.

The debt overhang measure, *Overhang*, is then calculated as the present value of lenders' rights to recoveries in default:

$$Overhang_{i,t} = \frac{D_{i,t}}{K_{i,t}} \times Recovery\, Rate \times \left[\sum_{s=1}^{20} \rho_{t+s} [1 - 0.05(s-1)](1+r)^{-s} \right] \quad (4.5)$$

where the subscripts i, t and s indicate a firm, a fiscal quarter and a number of years after the debt inception, respectively. $D/K \times Recovery\, Rate$ represents the capital-normalized value of collections in the event of default, where D is the firm's total debt, K is the firm's capital stock, *Recovery Rate* is an industry specific weighted recovery ratio of defaulted senior unsecured bonds by three-digit SIC code based on Altman and Kishore (1996). The expression in the brackets represents the value of hitting claim under the assumption of the long-term debt with the initial maturity of 20 years, which matures under a straight-line at a rate of 5% per year. The firms' default probability in period $t+s$ is denoted by ρ_{t+s}. r is a risk-free rate based on long-term Treasuries.

We calculate the firms' default probability as the expected default frequency (EDF) following the approach of Bharath and Shumway (2008), which hangs upon the functional form of Merton's (1974) distance to default (DD) model with no requirement of a numerical solution of the model:

$$\rho_{t+s} = EDF = N(-DD) = N\left(-\frac{ln(V/F) + (\mu - 0.5\sigma_V^2)(t+s)}{\sigma_V\sqrt{t+s}}\right) \tag{4.6}$$

where DD is the distance to default, V denotes the asset value of the firm, μ is the expected continuously compounded return on asset, σ_V is the asset value volatility, F is the face value of debt, $t+s$ is the forecasting period, $N(.)$ is the cumulative standard normal distribution.

Notably, our way of estimating the firm's default probability for the calculation of debt overhang differs from the existing literature. Specifically, Hennessy (2004), Hennessy, Levy, and Whited (2007) use Moody's reports of historical default hazard rates by bond rating to proxy for the probability of default. This approach significantly restricts the analysis of the debt overhang by reducing the sample of firms to the firms with credit rating, and assuming the same default probability for all firms in the same credit rating class. In contrast, we calculate the probability of default individually for each firm on the monthly basis, and use the value of expected default frequency as of the end of fiscal quarter.[9] Furthermore, Bharath and Shumway (2008) demonstrate that their approach of calculating EDF performs well against Moody's KMV model.

CDS trading activity

We measure CDS trading activity in the spirit of prior studies (e.g., Ashcraft and Santos, 2009, Saretto and Tookes, 2013) as an indicator variable equal to one in and after the first quarter of CDS trading on a reference firm and zero prior it (hereafter referred to as *CDS Active*). It allows us to capture the timing of CDS trade initiation and the change in the dependent variable following this moment.

[9]Alanis, Chava, and Kumar (2018) address the similar concern by using the predicted default probability from a discrete-time hazard model based on Shumway (2001), and Chava and Jarrow (2004).

Likelihood of empty creditor problem

We measure the likelihood of the empty creditor problem following the model's predictions developed in Chapter 3. The model indicates that the probability of lenders to turn into inefficient empty creditors in default state depends on the two model's parameters: the lenders' hedge ratio h and the parameter H representing borrower financial stability. In particular, the probability is higher for greater hedge ratio, and (or) weaker firm's fundamentals.

First, we construct an empirical proxy, $Hedge\,Ratio$, for the aggregate hedge ratio of lenders in the CDS market, denoted in the model as h. Specifically, it is defined as the net notional amount of CDS outstanding for a reference firm scaled by the amount of firms' total debt in a given quarter. Oehmke and Zawadowski (2016) emphasize that the net notional amount of CDS outstanding represents the more reliable measure of the amount of credit risk transferred in the CDS market due to the adjustment of the gross notional amount for offsetting positions. Consequently, it can be interpreted as the maximum amount of payments that need to be made between a CDS seller and a CDS buyer in the case of a credit event on a reference entity.

Next, we construct an empirical measure of firm financial stability, *Firm Stability*, which closely corresponds to the model's parameter H. H is a function of borrower characteristics (a decreasing function of firm's leverage and liquidation costs, and an increasing function of firm's productivity). The low (high) value of H is associated with low (high) firm financial stability. To incorporate the dependence of H on firm-specific characteristics and reduce measurement errors in its determinants, we calculate *Firm Stability* as a composite score measure of H.

Specifically, for each fiscal year of a given year, we sort firms into deciles based on each of the three partition variables of H, where leverage and liquidation costs have their sign changed before sorting so that H is increasing in all variables. We use Tobin's Q as the proxy for the firm's productivity, that corresponds to the parameter θ in our model. A higher value of Tobin's Q is associated with a high productivity shock experienced by the firm. With respect to liquidation costs, we follow Davydenko and Strebulaev (2007) suggesting a fraction of non-fixed assets in a firm as a good proxy for liquidation costs, which corresponds to the parameter $(1-\ell)$ in our model. We calculate leverage as the ratio of total debt to book value of assets. Finally, we calculate the average of sorted variables to get a composite score measure, *Firm Stability*.

A high (low) score, i.e. above (below) the median value, is indicative for high (low) firm financial stability, that is associated with the lower (greater) empty creditor threat. Note that the goal of calculating this measure was to determine borrowers' vulnerability to the empty creditor threat based on firms' characteristics rather than to precisely determine the parameter H, which can be directly substituted into the model in Chapter 3.

Financial covenant strictness

For debt covenant strictness, that corresponds to the parameter c^* in our model, we construct an empirical measure capturing the ex-ante aggregate probability of covenant violation in a debt contract. The stricter the covenant, the lower a borrower's distance to technical default that leads to a forced renegotiation between a lender and a borrower, and the higher shareholders' incentive to adjust corporate policy decisions to ensure the covenant compliance.

Motivated by prior measures of covenant strictness in the literature, Murfin (2012) emphasises that a comprehensive strictness measure should incorporate both the number of covenants in a debt contract and the initial slack of covenants (i.e., how tightly covenants are set to the associated financial ratios of a borrower at the time the contract is written), and adjust for the variance-covariance of the underlying accounting ratios. He is the first who demonstrates that the complex debt covenant strictness is a superior measure to alternative measures used previously in the literature. The inability of former measures to capture strictness accurately comes from their reliance on just individual components of the strictness, such as just for the number of covenants in a contract (covenant intensity index), or just for the slack of each individual covenant (e.g., Bradley and Roberts, 2015; Demerjian, 2011; Dichev and Skinner, 2002). Furthermore, all prior measures fail to capture the third important dimension of strictness: the covariance of the underlying accounting ratios. Where the lower correlation results in a greater probability of technical default.

In the spirit of Murfin (2012), in our analysis, we use the complex measure of debt covenant strictness for private loans (hereafter referred to as *FinCov*), which represents the aggregate probability that at least one financial covenant attached to a debt contract will be violated during the quarter after the loan inception. We concentrate on private loans due to the current data limitations of public loans, that makes calculation of the complex measure of covenant strictness impossible.[10] Specifically,

[10] The prior empirical studies examining the effect of CDSs on financial contracting also concentrate

Fixed Income Security Database (FISD), one of the main sources for public loans, identifies just bond covenant provisions without providing any additional information on their initial thresholds, needed for the calculation of covenant slackness.

FinCov is calculated following the non-parametric simulation approach by Demerjian and Owens (2016), who propose an alternative and more flexible method to the parametric simulation approach by Murfin (2012).[11] Furthermore, the method proposed by Demerjian and Owens (2016) relies on covenant-specific definitions that allows to minimise presumed measurement error concerns from using the Dealscan database, one of the main data sources for the empirical analysis of covenants in private loans. While Dealscan contains the detailed information on many aspects of the loan terms (e.g., amount, maturity, promised yields, loan type, loan purpose, lenders identity, covenant type, financial covenant threshold at the loan inception), it does not provide definitional details on how financial covenants are actually constructed in loan agreements. As a result, many empirical studies restrict attention to a small number of covenants by making assumption that accounting measures used for these covenants are standardized and unambiguous. In contrast, in our calculation, we use all 15 categories of financial covenants documented in Dealscan based on "standard" covenant definitions provided by Demerjian and Owens (2016). Specifically, Demerjian and Owens (2016) determine definitions for each Dealscan covenant category, that are most frequently used in actual contract terms (based on the Tearsheets database with information on 2,683 loan packages).

More details on the simulation approach and the covenants included in its computation are in Appendix.

4.4.2. Data and sample construction

We use a sample of U.S. public firms from the CRSP-Compustat merged database, providing information on firms' daily stock returns and quarterly accounting data, over the period from 1994 to 2016. We exclude financial firms (SIC 6000-6999), regulated utilities (SIC 4900-4999), and public service firms (SIC above 9000). In our sample selection, we also follow the previous literature in debt overhang and discard firm-quarters with book leverage outside of the unit interval, and missing data or

on covenant provisions of just private loans (e.g., see Chakraborty, Chava, and Ganduri, 2015; Shan, Tang, and Winton, 2019).

[11] The parametric simulation approach requires that quarterly changes in financial metrics underlying the covenants follow a multivariate lognormal distribution.

with negative (or zero) values for total assets, the capital stock, or sales.

Then for each firm - fiscal quarter (year) observation in the CRSP-Compustat, we find the matching company name and date (e.g., CDS trading inception dates, or the closest weekly net notional in time) from our CDS data sources. To determine starting dates of CDS trading on borrowers' debt, for greater accuracy we combine three data sources following Subrahmanyam, Tang, and Wang (2014): CreditTrade, the GFI Group and Markit. We have information on 546 North American corporates that have CDS trading initiated on their debt at some time during 1997-2013.[12] We extract CDS volume data from the Depository Trust and Clearing Corporation (DTCC), that captures almost the entire market for standard single-name CDS (95% by estimation of the DTCC). The DTCC reports on a weekly basis both the aggregate gross notional and the aggregate net notional amounts outstanding on a particular reference entity. Overall, we have data for 396 US corporate reference entities over the period between October 2008 (the starting point of the DTCC database) and October 2015.

Next, the resulting sample is matched with the loan data from Loan Pricing Corporation (LPC) Dealscan based on the Dealscan-Compustat link file as of April 2018 provided by Chava and Roberts (2008). Particularly, we match a Dealscan borrower company ID with a Compustat firm ID, and assign each firm's loan package to the fiscal quarter (year) when the loan package was issued. The Dealscan has detailed information on the majority of all commercial loans issued by bank and non-bank lenders in the US. We conduct our analysis at the loan package level owing to a fact that debt covenants generally pertain to all loans (also referred to as facilities or tranches) in a package. We concentrate on the sample of loans issued after 1994 due to the fact that the information on covenants is fairly limited in Dealscan prior this date. In addition, it gives us an opportunity to examine loan data three years before the first data on inception of CDS trading occurred in 1997. In the same logic, we choose 2016 as the end date of the sample, that is three years after the last available observation on the introduction of CDS trading (or a year after the available data on the net notional amount).

Finally, to define defaulting borrowers for the construction of the instrumental variable for the debt covenant strictness, we use monthly Compustat's rating database. We match the identified defaulting borrowers with the Dealscan. We keep

[12]The starting point of our CDS sample is the earliest available date, 1997, which is generally recognized as the origin year of the broad CDS market (Tett, 2009). See Subrahmanyam, Tang, and Wang (2014) for details of the CDS sample construction.

just information on defaults for loans which were outstanding at the time of default based on their start and maturity dates. As previously, we conduct our analysis at the loan package level.

4.4.3. Summary statistics

Table 4.1 reports the distribution of U.S. firms with active CDS trading by year and across industries (excluding financial, regulated utilities and public service firms) in the period between 1997 and 2013. Our final CRSP-Compustat merged sample includes 546 firms that have CDS traded on their debt. The largest number of active CDS contracts was during 2004-2008 period, and in manufacturing industry (52% of CDS firms). The CRSP-Compustat-Dealscan merged sample includes 396 distinct firms with active CDS trading.

Table 4.2 reports the summary statistics of firm and loan characteristics between 1994 and 2016. All continuous variables are winsorized at the 1th and 99th percentiles. Panel A presents the summary statistics for the whole sample, whereas Panel B provides the descriptive statistics for CDS firms versus non-CDS firms. With respect to the firm characteristics, on average, CDS traded firms are bigger, have lower investment, higher cash flow and firm leverage compared to non-CDS firms. In addition, we find that CDS traded firms are characterized by higher Altman's Z-score and lower debt overhang correction than non-CDS firms. With respect to the loan characteristics, on average, CDS traded firms have much larger size of loan facilities and packages issued at lower spreads through involving a larger number of participant and lead banks in loan syndicates compared to non-CDS firms. Loans of CDS firms have twice lower usage for refinancing purposes than non-CDS firms. CDS-referenced loans include lower number of financial covenants than non-CDS firms. The strictness of debt covenants in CDS-referenced loans is also lower (22% vs. 40%, respectively).

Panel C of Table 4.2 presents the descriptive statistics of lender characteristics in terms of recent borrower defaults in loan portfolios of lead arrangers. On average, lenders experience 1.2 defaults in the 90 days leading up to a contracting date of a new loan. In total, in the CRSP-Compustat-Dealscan merged sample, for the period between 1994 and 2016, lead arrangers experienced 562 borrowers' defaults.

Table 4.3 presents Pearson correlation coefficients between key variables used in the analysis. The correlation coefficient between investment and overhang is negative and statistically significant, consistent with theory. The relationships between investment and other explanatory variable are consistent with prior studies. The covenant strictness is positively associated with the overhang measure, and negatively associated with the measure of firm financial stability. The choice of explanatory variables does not suffer from multicollinearity, the absolute values of correlation coefficients do not exceed 0.8 (Studenmund, 2016, p.272).

Table 4.1: **Distribution of CDS firms.** This table reports the distribution of U.S. firms with CDS trading initiated on their debt between 1997 and 2013. *Panel A* reports the distribution of firms with active CDS trading per year based on the CRSP-Compustat and CRSP-Compustat-Dealscan merged samples. *Panel B* reports the distribution of CDS firms across industries based on the SIC code in the CRSP-Compustat merged sample.

Panel A: Distribution of firms with active CDS trading by year

	CRSP-Compustat sample		CRSP-Compustat-Dealscan sample	
Year	Total # firms	Active CDS firms	Total # firms	Active CDS firms
1994	3602	-	100	-
1995	3793	-	196	-
1996	3989	-	444	-
1997	4185	22	551	2
1998	4100	58	399	5
1999	3795	94	372	11
2000	3642	155	391	34
2001	3411	244	455	73
2002	3069	349	502	118
2003	2786	383	475	123
2004	2615	412	545	171
2005	2519	434	525	175
2006	2455	428	421	136
2007	2384	411	387	110
2008	2339	402	259	63
2009	2225	392	203	65
2010	2097	389	272	89
2011	2051	380	353	124
2012	1976	371	299	91
2013	1941	359	300	89
2014	2007	355	257	94
2015	2044	341	251	98
2016	1991	334	182	67
Total		546		396

Panel B: Distribution of CDS firms by industry

Industry	CDS firms	%
Mining	40	7.3
Construction	11	2.0
Manufacturing	282	51.6
Transportation	26	4.8
Communications	52	9.5
Wholesale Trade	15	2.7
Retail Trade	47	8.6
Services	73	13.4
Total	546	100.0 %

Table 4.2: **Summary statistics.** This table reports summary statistics of firm and loan characteristics with non-missing observations between 1994 and 2016. Firm characteristics are reported based on the CRSP-Compustat merged sample. Loan characteristics are reported based on the CRSP-Compustat-Dealscan merged sample used for the calculation of strictness of financial covenants. *Panel A* presents the descriptive statistics of the variables over the entire sample. *Panel B* presents the descriptive statistics of the variables for CDS firms versus non-CDS firms. *Panel C* presents the descriptive statistics of lender characteristics in terms of recent borrower defaults in loan portfolios of lead arrangers. All continuous variables are winsorized at the 1th and 99th percentiles. The definitions of variables are presented in Appendix 4.A1.

Panel A: Whole sample						
	N	mean	sd	p25	med.	p75
CDS trading						
Hedge ratio	6,724	0.294	0.463	0.065	0.151	0.347
CDS Active (binary)	229,716	0.115	0.319	0.000	0.000	0.000
CDS Firm (binary)	229,716	0.172	0.377	0.000	0.000	0.000
Firm characteristics						
Investment	229,716	0.068	0.078	0.025	0.047	0.083
Cash Flow	229,716	0.018	0.569	0.016	0.070	0.167
Tobin Q	229,716	1.872	1.567	1.103	1.445	2.083
Leverage	229,716	0.267	0.198	0.110	0.241	0.384
Nonfixed assets	229,716	0.707	0.229	0.583	0.775	0.888
Size	229,716	6.032	1.961	4.502	5.930	7.412
Altman	229,716	0.308	1.737	0.103	0.712	1.199
Rated	229,716	0.314	0.464	0.000	0.000	1.000
Firm Stability	229,716	5.485	1.656	4.333	5.500	6.667
Overhang	229,716	0.016	0.056	0.000	0.000	0.005
Underinvestment	97,754	0.034	0.053	0.008	0.019	0.038
Loan characteristics						
Facility amount (mln)	8,843	426.000	819.000	75.000	200.000	485.000
Package amount (bln)	8,843	8.570	18.000	0.309	1.800	7.500
Package maturity (months)	8,843	47.885	19.327	36.000	55.712	60.000
# participants	8,843	9.676	9.574	3.000	7.000	13.000
# lead lenders	8,843	1.719	1.349	1.000	1.000	2.000
Loan spread (%)	8,843	1.834	1.258	1.000	1.578	2.500
# covenants	8,843	2.264	1.023	2.000	2.000	3.000
% performance covenants	8,843	0.719	0.339	0.500	1.000	1.000
% capital covenants	8,843	0.281	0.339	0.000	0.000	0.500
FinCov	8,843	0.346	0.408	0.009	0.095	0.858
Secured (binary)	8,843	0.576	0.494	0.000	1.000	1.000
Corporate purpose (binary)	8,843	0.589	0.492	0.000	1.000	1.000
Refinancing purpose (binary)	8,843	0.193	0.395	0.000	0.000	0.000
Acquisition purpose (binary)	8,843	0.158	0.365	0.000	0.000	0.000

Table 4.2 - **Continued**

Panel B: CDS firms vs. non-CDS firms						
	CDS firms			Non-CDS firms		
	N	mean	med.	N	mean	med.
Firm characteristics						
Investment	37,146	0.052	0.043	192,570	0.071	0.048
Cash Flow	37,146	0.116	0.080	192,570	-0.003	0.067
Tobin Q	37,146	1.825	1.542	192,570	1.882	1.420
Leverage	37,146	0.311	0.284	192,570	0.258	0.227
Nonfixed assets	37,146	0.661	0.713	192,570	0.717	0.788
Size	37,146	8.705	8.660	192,570	5.478	5.461
Altman	37,146	0.774	0.820	192,570	0.215	0.681
Rated	37,146	0.896	1.000	192,570	0.194	0.000
Firm Stability	37,146	5.509	5.667	192,570	5.482	5.500
Overhang	37,146	0.008	0.000	192,570	0.018	0.000
Underinvestment	10,531	0.023	0.016	87,223	0.035	0.019
Loan characteristics						
Facility amount (mln)	2,625	930.477	550.000	6,218	212.259	125.000
Package amount (bln)	2,625	20.230	10.000	6,218	3.627	0.850
Package maturity (months)	2,625	45.955	57.509	6,218	48.710	55.000
# participants	2,625	15.263	13.000	6,218	7.304	5.000
# lead lenders	2,625	2.239	2.000	6,218	1.498	1.000
Loan spread (%)	2,625	1.309	1.025	6,218	2.056	1.823
# covenants	2,625	1.796	2.000	6,218	2.463	2.000
% performance covenants	2,625	0.671	1.000	6,218	0.739	0.750
% capital covenants	2,625	0.329	0.000	6,218	0.261	0.250
FinCov	2,625	0.224	0.015	6,218	0.399	0.162
Secured (binary)	2,625	0.297	0.000	6,218	0.695	1.000
Corporate purpose (binary)	2,625	0.616	1.000	6,218	0.578	1.000
Refinancing purpose (binary)	2,625	0.117	0.000	6,218	0.225	0.000
Acquisition purpose (binary)	2,625	0.139	0.000	6,218	0.167	0.000

Panel C: Lender characteristics						
	N	mean	sd	p10	med.	p90
Default 90 days	9,796	1.220	3.203	0	0	4
Default 90 days (different industry and state)	9,796	0.954	2.776	0	0	3
S&P Rating and Dealscan defaults by year		year	#		year	#
		1994	1		2006	7
		1995	8		2007	6
		1996	2		2008	26
		1997	2		2009	55
		1998	2		2010	11
		1999	42		2011	15
		2000	50		2012	11
		2001	70		2013	7
		2002	78		2014	6
		2003	45		2015	24
		2004	21		2016	43
		2005	13			
Total		562				

Table 4.3: **Correlation matrix.** This table reports Pearson correlations for the main variables used in the analysis. The definitions of variables are presented in Appendix 4.A1. The symbols ***,**, and * denote significance levels of 1%, 5%, and 10%, respectively.

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) Investment	1					
(2) Overhang	-0.051***	1				
(3) Cash Flow	0.129***	-0.201***	1			
(4) Tobin Q	0.289***	-0.162***	0.063***	1		
(5) FinCov	-0.074**	0.177***	-0.201***	-0.197***	1	
(6) Firm Stability	0.119***	-0.405***	0.043***	0.493***	-0.199***	1

4.5. Empirical Findings

This section presents our main empirical findings based on the research design developed in Section 4.3, and aimed at exploring and comparing the ability of commitment mechanisms to affect investment distortions caused by debt overhang. To ensure robustness of our findings, we then investigate cross-sectional heterogeneity in the baseline results based on the likelihood of the empty creditor threat and conduct an additional empirical analysis with an alternative measure of underinvestment.

4.5.1. CDS and debt overhang

To study the effect of CDSs on investment distortions created by debt overhang, we estimate equation (4.2) using an indicator of CDS trading activity, *CDS Active*, as a commitment mechanism variable, *Commit Mechanism*. We address potential heterogeneity in the CDS effect based on the likelihood of the empty creditor problem through replacing the binary variable *CDS Active* by *Hedge Ratio*, an empirical proxy for the aggregate hedge ratio of lenders for a particular borrower in the CDS market, and performing the analysis for subsamples split according to the value of the empirical proxy for firm financial stability, *Firm Stability*. Where the low (high) *Firm Stability*, i.e. below (above) the median value, indicates the weaker (stronger) firms' fundamentals, that are associated with greater (lower) firm vulnerability to the empty creditor threat.

Table 4.4 Panel A reports the results for the interaction of *Overhang* with *CDS Active*, representing the treatment effect over the entire post-CDS introduction period. Column 1 shows that the underinvestment effect of debt overhang is robust for the sample of our analysis. Column 2 indicates that the severity of the debt overhang problem is amplified after CDS contracts start trading on the debt of the average firm. The interaction coefficient $Overhang \times CDS\,Active$ is negative and statistically significant at the 5% level for the overall sample. This suggests that the investment-distortion effect of CDSs dominates for the average firm by undermining shareholders' incentive to undertake valuable investment. Economically, it implies that the initiation of CDS trading contributes to the negative effect of debt overhang on investment policy ceteris paribus by an additional 4.4%. Consistent with Hypothesis 2, the investment-distortion effect of CDSs is more prominent for borrowers with greater risk (i.e., low *Firm Stability*), which are more vulnerable to the empty creditor threat. Among firms with the lower risk, the coefficient estimate of $Overhang \times CDS\,Active$ is positive consistent with our theoretical predictions, but statistically insignificant.

Table 4.4 Panel B reports the results for the interaction of *Overhang* with *Hedge Ratio*. Column 1 shows that the underinvestment effect of debt overhang is robust for the smaller sample with available information on CDS net notional amounts after the fourth quarter of 2008 in DTCC. Consistent with our theoretical predictions, we observe that the negative effect of debt overhang on borrower investment policy is more prominent for the higher amount of CDS insurance written on firms (see, column 2). The interaction terms $Overhang \times Hedge\,Ratio$ are negative and statistically significant at the 5% and 10% levels, in the entire sample and the subsample of firms with higher financial risk, respectively. In terms of economic significance, a one standard deviation increase in the aggregate hedge ratio of lenders in the CDS market (0.463) ceteris paribus lowers investment by an additional 3.7%.

Finally, we address potential endogeneity issues associated with CDS trading by using the Big Bang Protocol of April 4, 2009 as a quasi-natural experiment, described in detail in Section 4.3.2. Table 4.5 reports the results for a difference-in-difference estimation of the joint effect of CDS trading and debt overhang on borrower investment policy over 12 calendar quarters around the CDS Big Bang Protocol. Consistent with our expectations, we find that the keys variables of interest, $Overhang \times CDS\,Firm \times PostBigBang$ and $Overhang \times Hedge\,Ratio \times PostBigBang$, are negative and statistically significant, suggesting that the CDS Big Bang exacerbated the empty creditor problem, thus forcing borrowers to forgo some value-increasing investment.

Overall, our findings indicate that the investment-distortion effect of CDSs dominates for the average firm and increases with the likelihood of the empty creditor threat. As a result, CDS contracts fail as a mechanism intended to reduce investment distortions caused by lack of commitment, instead they exacerbate debt overhang problem.

Table 4.4: **CDS and debt overhang.** This table presents the coefficients and robust standard errors clustered by firm, that are obtained from the panel regression analysing the joint impact of debt overhang and CDS trading on investment. Column 1 reports estimates of the individual effect of debt overhang on investment based on equation (4.1). In columns 2-4, according to equation (4.2), the dependent variable $Investment$ is regressed on the measure of CDS trading activity, which is defined as either $CDS\,Active$ (i.e., an indicator variable equal to one in the period after introduction of CDS trading) or $Hedge\,Ratio$ (i.e., CDS net notional amount scaled by total firm debt), $Overhang$ and the interaction term $Overhang \times CDS\,Active$ (or, $Overhang \times Hedge\,Ratio$). In columns 3-4, the sample is split according to the borrower vulnerability to the empty creditor threat, based on the measure of firm financial stability. Low (high) *Firm Stability*, i.e. below (above) the median value, indicates high (low) vulnerability. The definitions of variables are presented in Appendix 4.A1. All specifications include firm and time (calendar quarter - year) fixed effects. The symbols ***,**, and * denote significance levels of 1%, 5%, and 10%, respectively.

	All	All	Low Firm Stability	High Firm Stability
	(1)	(2)	(3)	(4)
Panel A: CDS Variable = CDS Active				
Overhang × CDS Active		-0.044**	-0.064***	0.020
		(0.019)	(0.018)	(0.007)
Overhang	-0.048***	-0.045***	-0.019**	-0.023***
	(0.009)	(0.009)	(0.009)	(0.006)
CDS Active		0.008***	0.002	0.013***
		(0.001)	(0.002)	(0.002)
Cash Flow	0.002***	0.002***	0.001***	0.003***
	(0.000)	(0.000)	(0.000)	(0.001)
TobinQ	0.008***	0.008***	0.013***	0.006***
	(0.001)	(0.001)	(0.001)	(0.000)
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Observations	229,716	229,716	115,487	111,981
R-squared	0.29	0.29	0.31	0.35
Panel B: CDS Variable = Hedge Ratio				
Overhang × Hedge Ratio		-0.079**	-0.055*	-0.014
		(0.035)	(0.032)	(0.092)
Overhang	-0.054**	-0.021	-0.024	-0.025
	(0.024)	(0.024)	(0.026)	(0.079)
Hedge Ratio		0.002	0.002	0.002
		(0.002)	(0.002)	(0.003)
Cash Flow	0.001***	0.001***	0.001***	0.006***
	(0.001)	(0.001)	(0.001)	(0.008)
TobinQ	0.012***	0.012***	0.014***	0.010***
	(0.003)	(0.003)	(0.004)	(0.004)
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Observations	6,724	6,724	3,618	3,106
R-squared	0.57	0.58	0.60	0.59

Table 4.5: **CDS and debt overhang: a quasi-natural experiment.** This table reports estimates from the panel regression analysing the joint impact of debt overhang and CDS trading on investment over 12 calendar quarters around the introduction of the Big Bang Protocol on April 4, 2009. Column 1 reports estimates of the individual effect of debt overhang on investment based on equation (4.1). Columns 2-4 report estimates of the joint impact of debt overhang and CDS trading on investment based on modified equation (4.2) in Section 4.3.2. $CDS\,Firm$ is an indicator variable equal to one if the firm has CDSs traded over the total sample period. $PostBigBang$ is an indicator of the post-event period. In columns 3-4, the sample is split according to the borrower vulnerability to the empty creditor threat, based on the measure of firm financial stability. Low (high) *Firm Stability*, i.e. below (above) the median value, indicates high (low) vulnerability. The definitions of variables are presented in Appendix 4.A1. All specifications include firm and time (calendar quarter - year) fixed effects. The symbols ***,**, and * denote significance levels of 1%, 5%, and 10%, respectively.

	All	All	Low Firm Stability	High Firm Stability
	(1)	(2)	(3)	(4)
Panel A: CDS Variable = CDSFirm				
Overhang × CDSFirm × PostBigBang		-0.028**	-0.030**	0.013
		(0.024)	(0.021)	(0.010)
Overhang × CDSFirm		-0.033**	-0.020**	0.089
		(0.020)	(0.021)	(0.030)
Overhang × PostBigBang		0.018	0.006	-0.096
		(0.018)	(0.021)	(0.035)
CDSFirm × PostBigBang		0.003**	0.001	0.004*
		(0.002)	(0.002)	(0.002)
Overhang	-0.037***	-0.049***	-0.037***	-0.031**
	(0.010)	(0.011)	(0.014)	(0.015)
Controls	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Observations	23,152	23,152	11,824	11,328
R-squared	0.53	0.53	0.58	0.55
Panel B: CDS Variable = Hedge Ratio				
Overhang × HedgeRatio × PostBigBang		-0.026*	-0.048**	-0.013*
		(0.051)	(0.060)	(0.070)
Overhang × HedgeRatio		-0.036**	-0.065**	-0.016
		(0.056)	(0.065)	(0.070)
Overhang × PostBigBang		0.010	0.007	0.004
		(0.020)	(0.031)	(0.033)
HedgeRatio × PostBigBang		-0.005	-0.007	0.001
		(0.003)	(0.006)	(0.003)
Overhang	-0.047***	-0.044**	-0.047*	-0.016**
	(0.018)	(0.025)	(0.034)	(0.038)
Controls	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Observations	2,263	2,263	1,187	1,076
R-squared	0.70	0.70	0.77	0.63

4.5.2. Covenants and debt overhang

Next, we empirically examine the effectiveness of debt covenants as a commitment mechanism to reduce investment distortions created by debt overhang. Theoretically, we expect a lower negative effect of debt overhang for the stricter financial covenants, i.e. for the higher value of *FinCov*. Since our measure of covenant strictness is potentially endogenous in the presence of simultaneity (the strictness of debt covenants at the loan inception is determined jointly with the firm corporate policies), we employ the instrumental variable approach by conducting a 2SLS regression, described in detail in Section 4.3.2.

In the first stage, we estimate an aggregated strictness of financial covenants included in a loan based on equation (4.4). We use the number of recent defaults in the loan portfolio of the lead loan arranger prior contracting a new loan as an instrument. We report the results of the first stage based on the number of defaults for different time periods ranging between 0 and 360 days in Table 4.6 Panel A (columns 1 - 4). The number of recent defaults positively and significantly at the 1% level predicts the covenant strictness of new loans for the same lead arrangers, suggesting that the instrument satisfies the relevance condition. In addition, we can reject the hypothesis of a weak instrument given that p-value is less than 0.01 and Sargan F-test statistic is above 10.

The results in Table 4.6 Panel A demonstrate that lenders are more sensitive to the most recent defaults, such as those experienced in the past 90 days prior contracting. The economic magnitude of the estimated coefficient for *Default 90 days* implies that covenant strictness of new loans (ranging from 0 to 100) increases by 0.60 in response to each incremental default in lead lenders' loan portfolios. Hereinafter, to carry out 2SLS regressions, we focus on the number of defaults over the 90-day period.

In Table 4.6 Panel B, we conduct the test on the sensitivity of our instrument for geographic and/or industry-specific risks. Specifically, in the estimation of covenant strictness for new loans, we exclude defaults with the same 1-digit SIC code, or in the same state as the contracting borrower, or both. This allows us to consider the effect of defaults of unrelated borrowers in lenders' portfolios on the strictness of new contracting loans. The estimated coefficients for *Default 90 days* remain positive and statistically significant at the 1% level, reinforcing that the chosen instrument represents a distinct lender (supply-side) effect.

Table 4.6: **Endogeneity of debt covenant strictness: first stage of IV/2SLS.** This table reports estimates from the first stage of the IV approach, according to equation (4.4), with debt covenant strictness instrumented by number of defaults on lead lenders' loan portfolios in N days prior to contracting. Debt covenant strictness ranges 0 - 100, and represents the probability that the borrower will violate at least one covenant in next quarter after the loan inception. *Default N days* is calculated as the number of outstanding loan packages in the loan portfolio of the lead lender that defaulted (i.e., for which the borrower's rating was changed to *Default* or *Selective Default* based on S&P rating database) N days prior contracting of a new loan. *Panel A* presents estimates of the fixed-effect regression of debt covenant strictness on recent defaults, where N days ranges 90 - 360 days before contracting. *Panel B* repeats the analysis for the instrument *Default 90 days* and tests its sensitivity to borrowers' location and industry (i.e., through excluding defaults with the same 1-digit SIC code as the contracting borrower, or in the same state, or both). The definitions of variables are presented in Appendix 4.A1. All specifications include firm, time (calendar quarter - year), lender fixed effects, and borrowers' rating dummies. The symbols ***,**, and * denote significance levels of 1%, 5%, and 10%, respectively.

Panel A: Financial covenant strictness

	(1)	(2)	(3)	(4)
Default 90 days	0.601***			
	(0.126)			
Default 180 days		0.365***		
		(0.077)		
Default 270 days			0.236***	
			(0.058)	
Default 360 days				0.203***
				(0.048)
Altman	-5.265***	-5.297***	-5.298***	-5.303***
	(0.803)	(0.803)	(0.803)	(0.803)
Loan maturity	-0.091	-0.088	-0.072	-0.044
	(0.815)	(0.815)	(0.817)	(0.817)
Loan amount	-3.335***	-3.321***	-3.294***	-3.265***
	(0.640)	(0.640)	(0.641)	(0.641)
Number participants	5.870***	5.858***	5.805***	5.755***
	(1.072)	(1.072)	(1.073)	(1.073)
Number lead lenders	-3.723***	-3.824***	-3.730***	-3.794***
	(1.050)	(1.054)	(1.057)	(1.058)
Rating dummies	YES	YES	YES	YES
Lender FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Observations	9,796	9,796	9,796	9,796
R-squared	0.64	0.64	0.64	0.64

Table 4.6 - **Continued**

Panel B: IV's dependence on borrowers' location and industry				
	All	Different Industry	Different State	Different Industry & State
	(1)	(2)	(3)	(4)
Default 90 days	0.601***	0.569***	0.635***	0.614***
	(0.126)	(0.139)	(0.136)	(0.149)
Controls	YES	YES	YES	YES
Rating dummies	YES	YES	YES	YES
Lender FE	YES	YES	YES	YES
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Observations	9,796	9,796	9,796	9,796
R-squared	0.64	0.64	0.64	0.64

We then use the fitted value of the covenant strictness, $\underline{FinCov}$, for the second-stage estimation based on the empirical design of equation (4.2). In comparison with measures of CDS trading activity, our measure of debt covenant strictness, being related to the initial covenant threshold, is available just at the particular point of time, at the loan inception. That reduces the sample for our analysis.[13] To address this issue in our empirical design, we follow the extant literature analysing the ex ante effect of debt covenants on borrower corporate policies and focus on a short time period after the loan inception (e.g., see Demiroglu and James, 2010; Li, Vasvari, and Wittenberg-Moerman, 2016). Particularly, we study the joint effect of debt covenants and overhang on firm investment policy from a quarter to four quarters after the loan inception.[14]

We report the results of our estimation based on both OLS and the second stage of IV/2SLS regressions in Table 4.7.

[13]Demerjian and Owens (2016) emphasize that even though the strictness measure of debt covenants can be technically updated subsequent to the loan inception, it may introduce additional measurement error due to covenant threshold adjustments over the life of the loan, information on which is not available. Dealscan reports just initial covenant thresholds without updating the database on its adjustments. Whereas the existing literature documents that debt covenants are a subject of frequent renegotiation over the life of the loan (e.g., see Denis and Wang, 2014; Roberts, 2015). For instance, Denis and Wang (2014) document that 53% of all debt contracts and 76% of all debt renegotiations, the majority of which occur in the absence of any covenant violation, modify at least one of the restrictive or financial covenants. They also show that, on average, the absolute values of changes to debt covenants range from over 30% to over 80%.

[14]We do not consider time period longer than four quarters after the loan inception for the same reason we do not update the measure of debt covenant strictness over time. The assumption is based on the frequency of covenant renegotiation, that the typical bank loan is renegotiated every nine months (Roberts, 2015).

Table 4.7: **Covenants and debt overhang: OLS and IV/2SLS.** This table presents the coefficients and robust standard errors clustered by firm, that are obtained from OLS and the second stage of IV/2SLS regressions analysing the joint impact of debt overhang and financial covenants on investment. *Panel A* presents the estimation results from OLS investment regressions. *Investment* is defined both as a quarter after and four quarters after the loan inception, in columns 1-2 and 3-4, respectively. Columns 1 and 3 report estimates of the individual effect of debt overhang on investment based on equation (4.1). In columns 2 and 4, based on equation (4.2), the dependent variable *Investment* is regressed on *FinCov* (i.e., an aggregated measure of strictness of financial debt covenants included in a loan package as of loan inception), *Overhang* and the interaction term *Overhang* × *FinCov*. *Panel B* presents the estimation results from IV/2SLS with financial covenant strictness $\underline{FinCov}$ instrumented by number of defaults on lead lenders' loan portfolios in 90 days prior to contracting of a new loan. The definitions of variables are presented in Appendix 4.A1. All specifications include firm and time (calendar quarter - year) fixed effects. The symbols ***,**, and * denote significance levels of 1%, 5%, and 10%, respectively.

	Investment$_{t+1}$		Investment$_{t+4}$	
	(1)	(2)	(3)	(4)
Panel A: OLS				
Overhang × FinCov		-0.020		-0.001
		(0.057)		(0.011)
Overhang	-0.061**	-0.043**	-0.014***	-0.013**
	(0.030)	(0.032)	(0.005)	(0.006)
FinCov		-0.010***		-0.005***
		(0.003)		(0.004)
Cash Flow	0.009***	0.008***	0.002***	0.002***
	(0.002)	(0.002)	(0.003)	(0.003)
TobinQ	0.018***	0.017***	0.028***	0.027***
	(0.002)	(0.002)	(0.003)	(0.003)
Firm FE	YES	YES	YES	YES
Time FE	YES	YES	YES	YES
Observations	8,843	8,843	8,418	8,418
R-squared	0.66	0.67	0.63	0.63
Panel B: Instrumented covenant strictness				
Overhang × $\underline{FinCov}$		0.023*		0.055***
		(0.014)		(0.019)
Overhang		-0.021**		-0.034**
		(0.007)		(0.010)
$\underline{FinCov}$		-0.031***		-0.040***
		(0.005)		(0.008)
Controls		YES		YES
Firm FE		YES		YES
Time FE		YES		YES
Observations		6,929		6,552

The estimated coefficients of the interaction term $Overhang \times FinCov$ based on the OLS regressions are negative and statistically insignificant. However, the effect of covenants on debt overhang problem might be potentially masked due to endogeneity of loan contract design to firm characteristics. Once we introduce the instrumental variable approach, we observe that debt covenants allow to restore shareholders' investment incentives by reducing the negative effect of debt overhang on investment policy. Similarly, in the analysis of the effect of covenants on firm operating performance, Spyridopoulos (2019) provides evidence that the estimated coefficient of covenants strictness based on OLS regressions is negatively biased and requires endogeneity addressing.

The observed value-enhancing effect of covenants through mitigation of debt overhang is more pronounced in four quarters rather than in the one quarter after the loan origination (the coefficients of the interaction term $Overhang \times \underline{FinCov}$ are positive and statistically significant at the 1% and 10% levels, respectively). Economically, a one standard deviation increase in debt covenant strictness (0.408) ceteris paribus raises investment by 2.23%, allowing to reduce the negative effect of debt overhang.

Together with the findings in the previous section, we demonstrate that CDSs and covenants are not equally effective mechanisms reducing costs of no-commitment. Covenants represent a more universal tool for debt protection and cannot be substituted by CDS trading. Thereby, the reason of a negative correlation between covenant strictness and CDSs observed empirically by Shan, Tang, and Winton (2019) might be found elsewhere.

4.5.3. Joint effect of CDS and covenants on debt overhang

Finally, to test whether the reduced incentive of CDS-protected lenders to use debt covenants is driven by a reason other than the substitution effect, we examine any changes in covenant effectiveness post CDS inception.

To do it, we test the joint effect of covenants and CDSs on the investment effect of debt overhang by estimating equation (4.3). Similarly to the analysis on the individual effect of covenants on debt overhang, we concentrate on the time period of four quarters after the loan inception. The interaction term $Overhang \times FinCov \times CDS\,Active$ is the variable of interest, which reflects any changes in effectiveness of financial covenants in mitigating underinvestment caused by debt overhang post

CDS inception. The positive (negative) sign of the interaction indicates the enhanced (reduced) covenant effectiveness. As previously, we address potential endogeneity concerns with respect to covenant strictness and CDS trading by using the instrumental variable approach and the quasi-natural experiment, respectively.

Table 4.8 Panel A reports the results of estimations based on the second stage of IV/2SLS regressions for the entire CRSP-Compustat-Dealscan sample. Consistent with our theoretical predictions, we find a negative sign of the triple interaction $Overhang \times \underline{FinCov} \times CDS\,Active$ for the overall sample and for the subsample of firms with greater risk, which are more vulnerable to the empty creditor threat (statistically significant at the 1% and 5% levels, respectively).[15] This suggests that CDS trading on a borrower debt makes financial covenants less effective as a mechanism against no-commitment. On the contrary, among firms with the lower risk, the coefficient estimate of $Overhang \times \underline{FinCov} \times CDS\,Active$ is positive consistent with our theoretical predictions, but statistically insignificant.

Table 4.8 Panel B reports the results of estimations based on the second stage of IV/2SLS regressions for the sample over 12-28 calendar quarters around the introduction of Big Bang Protocol on April 4, 2009. In comparison with Panel A, the number of observations drops significantly from 6,552 to 295 (12 quarters around the event), 963 (20 quarters around the event) and 1,743 (28 quarters around the event). The coefficients of the interaction term $Overhang \times \underline{FinCov} \times CDS\,Firm \times PostBigBang$ are negative in all columns, and significant in two out of three specifications for the longer sample periods. Consistent with our predictions, this suggests that the implementation of the Big Bang Protocol increases the empty creditor threat, which in turn exacerbates debt overhang problem and reduces covenant effectiveness.

Overall, the above results indicate that the introduction of CDS trading can reduce the rationales for covenants in a loan agreement through its detrimental effect on covenant effectiveness.

[15]The coefficient estimates for two-way interaction terms are generally consistent with the foregoing analysis. One exception, however, is the coefficient estimate for $Overhang \times CDS\,Active$, which has an opposite sign than in Table 4.4, and is not statistically significantly different from zero. That can be explained by using a much smaller sample than in the analysis of the joint impact of debt overhang and CDS trading on investment, and concentrating particularly on the sample of firms with private loans associated with debt covenants (i.e., on firms, for which it was possible to calculate an aggregate probability of covenant violation).

Table 4.8: **CDS, covenants and debt overhang.** This table presents the coefficients and robust standard errors clustered by firm, that are obtained from the panel regressions analysing the joint effect of financial covenants and CDS trading on the investment effects of debt overhang. Based on equation (4.3), the dependent variable $Investment_{t+4}$ is regressed on $FinCov$, $CDS\ Active$, $Overhang$, and interactions between these three variables. The interaction term $Overhang \times FinCov \times CDS\ Active$ is a variable of interest, that examines any changes in effectiveness of financial debt covenants in mitigating underinvestment agency distortions caused by debt overhang post CDS inception. *Panel A* reports estimation results of the second stage of 2SLS instrumental variable regressions with instrumented financial covenant strictness. In columns 2-3, the sample is split according to the borrower vulnerability to the empty creditor threat, based on the measure of firm financial stability. Low (high) *Firm Stability*, i.e. below (above) the median value, indicates high (low) vulnerability. *Panel B* reports estimation results with instrumented financial covenant strictness over 12-28 calendar quarters around the introduction of the Big Bang Protocol on April 4, 2009. The definitions of variables are presented in Appendix 4.A1. All specifications include firm and time (calendar quarter - year) fixed effects. The symbols ***, **, and * denote significance levels of 1%, 5%, and 10%, respectively.

	All	Low Firm Stability	High Firm Stability
	(1)	(2)	(3)
Panel A: Instrumented covenant strictness			
Overhang × FinCov × CDS Active	-0.078***	-0.057**	0.037
	(0.026)	(0.026)	(0.019)
Overhang × FinCov	0.054***	0.037**	0.039**
	(0.021)	(0.019)	(0.017)
Overhang	-0.036**	-0.023*	-0.031*
	(0.014)	(0.013)	(0.064)
Overhang × CDS Active	0.033	0.015	0.066
	(0.018)	(0.018)	(0.075)
FinCov × CDS Active	0.023**	0.033***	0.033**
	(0.010)	(0.013)	(0.016)
FinCov	-0.033***	-0.047***	-0.034**
	(0.009)	(0.011)	(0.013)
CDS Active	-0.018***	-0.022***	-0.004
	(0.004)	(0.007)	(0.005)
Controls	YES	YES	YES
Firm FE	YES	YES	YES
Time FE	YES	YES	YES
Observations	6,552	3,572	2,980

Panel B: Instrumented covenant strictness: around the Big Bang Protocol	12 quarters	20 quarters	28 quarters
	(1)	(2)	(3)
Overhang × FinCov × CDS Firm × PostBigBang	-0.002	-0.011*	-0.020**
	(0.205)	(0.045)	(0.024)
Interaction terms	YES	YES	YES
Controls	YES	YES	YES
Firm FE	YES	YES	YES
Time FE	YES	YES	YES
Observations	295	963	1743

4.6. Robustness Check

4.6.1. Alternative measures of the likelihood of empty creditor threat

In Section 4.2, we emphasize that our main theoretical predictions on the CDS effects on debt overhang and covenant effectiveness are conditional on the likelihood of the empty creditor threat (Hypotheses 2-3). The baseline results discussed above provide support to our predictions demonstrating more pronounced underinvestment post CDS inception for the higher amount of CDS insurance written on firms and the borrowers with weaker fundamentals. Similarly, we find analogous heterogeneity in the results for the negative effect of CDS trading on covenant effectiveness. In this section, we provide an additional analysis on cross-sectional heterogeneity in our baseline results based on the likelihood of firms to face empty creditors.

The first element contributing to the severity of the empty creditor problem is firm financial stability. So far, to measure firm financial stability, we have used the empirical proxy which closely corresponds to the model parameter H. As a robustness check, we use alternative measures of firm risk, such as firm leverage, investment grade and cash flow volatility. The second element contributing to the severity of the empty creditor problem is how much CDS insurance is written on firms. Based on the current literature, we identify types of firms for which creditors have a higher tendency to over-insure in the CDS market and explore the heterogeneity in our baseline results.

We first sort firms according to shareholders' bargaining power. Colonnello, Efing, and Zucchi (2019) show theoretically and empirically that creditors buy more CDS insurance in the presence of powerful shareholders, who can extract a larger surplus share in distressed debt renegotiation. That, in turn, enhances the empty creditor problem and increases the bankruptcy risk in those firms.[16] To test it, we divide the sample into two groups according to the percentage of equity held by institutional investors, used frequently in the previous literature as an empirical proxy for shareholder bargaining power (e.g., see Davydenko and Strebulaev, 2007). The higher institutional ownership is associated with better coordinated and more sophisticated investors, that allows a firm to bargain more effectively with existing debtholders on

[16] This prediction on shareholder bargaining power is also consistent with our model's predictions in Chapter 3, which indicate that the CDS-induced debt overhang increases with shareholder bargaining power.

behalf of shareholders.

Second, we examine whether the CDS - debt overhang relation is moderated by the level of renegotiation frictions (i.e., how difficult it is to renegotiate the debt). The recent theoretical study of Wong and Yu (2018) demonstrates that, to enhance commitment benefits of CDS contracts, debt holders acquire more credit protection as renegotiation costs decrease. While the increased use of CDS hedging enhances debt overhang.[17] To determine empirical proxies for renegotiation frictions, we follow Davydenko and Strebulaev (2007) and use the normalized number of institutional shareholders and the proportion of short-term debt in the capital structure. The first empirical proxy measures the dispersion of equityholders. The higher dispersion, the greater coordination problems, and as a result the greater renegotiation frictions. The second empirical proxy is based on findings indicating that firms with a higher proportion of short-term debt (as opposed to long-term-debt) have lower incentives to renegotiate debt given rare debt forgiveness of short-term creditors and more frequent concessions made by subordinated long-term creditors (Berglöf and Von Thadden, 1994; Gertner and Scharfstein, 1991).

Third, we split the sample according to the costs of liquidation. Danis and Gamba (2018) and Wong and Yu (2018) demonstrate that CDS-protected lenders choose a higher hedge ratio for firms with high bankruptcy costs given greater vulnerability of creditors to the strategic default threat.[18] We determine two empirical proxies for liquidation costs following the extant literature. The first empirical proxy, *Nonfixed assets*, is based on Davydenko and Strebulaev (2007) and calculated as one minus the ratio of net property, plant, and equipment to total assets. The second empirical proxy, *Intangibles*, is based on Favara, Schroth, and Valta (2012) and calculated as one minus the ratio of the weighted average of different tangible assets (such as, receivables, inventories, net property, plant, and equipment, and cash) to total assets.

We then reestimate equations (4.2) and (4.3) with instrumented covenant strictness separately for subsamples, representing low/high firm risk and low/high creditors' tendency to over-insure in CDSs. We provide the definitions of variables in Appendix 4.A1. The results are tabulated in Table 4.9. For brevity, we only

[17]The current literature also indicates the relation between debt overhang and renegotiation frictions. Specifically, Pawlina (2010) shows theoretically that debt overhang can be reduced by higher renegotiation frictions.

[18]Furthermore, as discussed in Section 4.4, our model parameter H is a decreasing function of firm liquidation costs. The lower H, the greater empty creditor threat, and, as a result, the greater investment-distortion effect of CDS trading.

report the coefficients of key variables of interest, *Overhang* $\times$ *CDS Active* and *Overhang* $\times$ <u>*FinCov*</u> $\times$ *CDS Active*. The cross-sectional analysis supports our argument that CDS-induced debt overhang and covenant effectiveness loss increase with the likelihood of firms to face empty creditors. Specifically, we find the more pronounced detrimental effect of CDS trading in the subsamples of firms with higher risk (i.e., firms with high firm leverage, high cash flow volatility, and a long-term debt rating below investment grade), and firms for which creditors have a higher tendency to over-insure (i.e., firms with high shareholders' bargaining power, low renegotiations costs, and high liquidation costs).

Table 4.9: **Cross-sectional heterogeneity in results.** This table presents the coefficients and robust standard errors clustered by firm, that are obtained from estimation of equations (4.2) and (4.3) with instrumented covenant strictness. In *Panel A*, the sample is split according to the level of firm risk. Firms with higher risk are presented by the high firm leverage (above the median), high cash flow volatility (above the median) and no investment grade. In *Panel B*, we split the sample into two groups based on the median percentage of institutional ownership, that represents shareholders' bargaining power. In *Panel C*, we partition the sample into two subsamples based on the level of renegotiation frictions. Firms with the high proportion of short-term debt and number of institutional shareholders (i.e., above the median) face greater renegotiation frictions. In *Panel D*, the sample is split based on the median level of liquidation costs, measured by two empirical proxies following Davydenko and Strebulaev (2007) and Favara, Schroth, and Valta (2012). For CDS-traded firms, the partition variables are measured 4 quarters prior to CDS trade initiation. The definitions of variables are presented in Appendix 4.A1. All specifications include firm and time (calendar quarter - year) fixed effects. The symbols ***, **, and * denote significance levels of 1%, 5%, and 10%, respectively.

Proxy	Key independent variable	Model 1		Model 2	
		Low/yes	High/no	Low/yes	High/no
Panel A: Firm risk		(1)	(2)	(3)	(4)
	Overhang × CDS Active	-0.036	-0.066***		
		(0.044)	(0.020)		
Leverage	Overhang × <u>FinCov</u> × CDS Active			-0.070	-0.066***
				(0.012)	(0.025)
	Observations	116,064	111,404	1,966	4,022
	Overhang × CDS Active	-0.040	-0.048**		
		(0.031)	(0.020)		
Investment grade	Overhang × <u>FinCov</u> × CDS Active			0.020	-0.069**
				(0.059)	(0.031)
	Observations	25,180	202,288	1,367	5,048

Table 4.9 **- Continued**

Proxy	Key independent variable	Model 1		Model 2	
		Low	High	Low	High
		(1)	(2)	(3)	(4)
Cash flow volatility	Overhang × CDS Active	-0.027	-0.048**		
		(0.028)	(0.023)		
	Overhang × FinCov × CDS Active			-0.034	-0.079***
				(0.095)	(0.022)
	Observations	101,739	114,022	1,339	4,879
		Low	High	Low	High
Panel B: Shareholder bargaining power		(1)	(2)	(3)	(4)
	Overhang × CDS Active	-0.022	-0.045**		
		(0.015)	(0.020)		
Institutional ownership	Overhang × FinCov × CDS Active			-0.022	-0.068***
				(0.017)	(0.025)
	Observations	51,537	83,765	1380	3,311
		Low	High	Low	High
Panel C: Renegotiation frictions		(1)	(2)	(3)	(4)
	Overhang × CDS Active	-0.052**	0.002		
		(0.022)	(0.022)		
Short-term debt	Overhang × FinCov × CDS Active			-0.047*	0.050
				(0.025)	(0.060)
	Observations	129,848	97,620	4,888	1,151
Norm. no. of shareholders	Overhang × CDS Active	-0.012***	-0.023		
		(0.046)	(0.034)		
	Overhang × FinCov× CDS Active			-0.064***	-0.032
				(0.087)	(0.060)
	Observations	58,830	78,035	2,275	1,331
		Low	High	Low	High
Panel D: Liquidation costs		(1)	(2)	(3)	(4)
	Overhang × CDS Active	0.015***	-0.062***		
		(0.025)	(0.022)		
Nonfixed assets	Overhang × FinCov× CDS Active			0.077	-0.060**
				(0.064)	(0.031)
	Observations	117,275	110,181	3,432	2,815
	Overhang × CDS Active	0.017	-0.071***		
		(0.024)	(0.024)		
Intangibles	Overhang × FinCov × CDS Active			-0.045	-0.081***
				(0.047)	(0.026)
	Observations	107,401	120,056	2,328	3,832

4.6.2. Measurement errors

Our baseline empirical specification (4.1-4.2) can suffer from measurement errors. The inclusion of proxies for unobservable variables, such as marginal q and debt overhang, can bias regression coefficients. One of the common methods to address this issue is to find additional observable variables that can serve as instruments. However, in many situations it is very difficult to do because such variables might be simply unavailable. Instead, we address this problem by using linear-cumulant equations to approximate the minimum distance consistent estimator suggested by Erickson, Jiang, and Whited (2014).

Table 4.10 reports the results of fifth-order cumulant estimators with two mismeasured regressors: *Overhang* and *TobinQ*. In Column 1, we estimate our baseline investment regression (4.1) and the coefficient for our proxy of debt overhang remains negative and statistically significant. In Column 2, we estimate our regression (4.2) with the interaction of Overhang and an indicator of the start of CDS trading. The result is consistent with our previous findings that CDSs do not alleviate, but exacerbate debt overhang problem. The absolute values of coefficients for both *Overhang* and *TobinQ* increase in comparison with corresponding estimates from OLS in Table 4.4.

In foregoing analysis, we address endogeneity of the measure of covenant strictness through a two-stage instrumental variable approach, that makes it impossible to combine with the fifth-order cumulant estimators. In next section, as a robustness check, we propose an alternative measure of underinvestment, which can be tested on both commitment mechanisms.

4.6.3. Alternative measure of investment inefficiency

To test how the commitment mechanisms of interest affect investment-related agency costs, so far we have focused on the empirical proxy for the debt overhang capturing the likelihood that a firm is operating in settings prone to underinvestment (high leverage, high probability of default, high lender recoveries in default). As a robustness check, we follow the extant literature in accounting and use an alternative measure of investment inefficiency by modelling the expected optimal level of firm-specific capital investment and the deviations from it (e.g., see Biddle, Hilary, and Verdi, 2009; Chen, Hope, Li, and Wang, 2011).

Table 4.10: **Measurement errors.** This table tests the robustness of our results to measurement errors in our proxies for marginal q and debt overhang by using linear-cumulant equations to approximate the minimum distance consistent estimator according to Erickson, Jiang, and Whited (2014). We present the minimum distance estimates from the fifth-order cumulant estimator. Column 1 reports estimates of the individual effect of debt overhang on investment based on equation (4.1). Column 2 reports estimates of the joint impact of debt overhang and CDS trading on investment based on equation (4.2). The definitions of variables are presented in Appendix 4.A1. All specifications include firm and time (calendar quarter - year) fixed effects. The symbols ***,**, and * denote significance levels of 1%, 5%, and 10%, respectively.

	(1)	(2)
Overhang × CDS Active		-0.058**
		(0.024)
Overhang	-0.059***	-0.056***
	(0.020)	(0.020)
CDS Active		0.006***
		(0.000)
Cash Flow	0.002***	0.002***
	(0.000)	(0.000)
TobinQ	0.009***	0.009***
	(0.001)	(0.001)
Firm FE	YES	YES
Time FE	YES	YES
Observations	229,716	229,716

In the neoclassical theory of investment, the marginal Q ratio represents the sole driver and the sufficient statistic for the optimal rate of investment when there are convex costs of adjusting the capital stock (e.g., see Abel and Eberly, 1994; Hayashi, 1982). Firms invest in capital until the marginal cost of capital is equal to the marginal benefit. However, under the agency framework, the literature also recognizes that, in some states of nature, firms may deviate from the expected level and follow a suboptimal investment policy (e.g., see Jensen and Meckling, 1976; Myers, 1977).

We first estimate the expected optimal investment cross-sectionally for each industry-quarter by using a parsimonious model of firm's growth opportunities (with at least 30 observations in each industry-quarter)[19]:

$$Investment_{i,t} = \beta_0 + \beta_1 TobinQ_{i,t-1} + \epsilon_{i,t}, \tag{4.7}$$

where the error term from the regression model reflects deviations from the predicted

[19]In untabulated results, given the potential measurement errors in average Q (e.g., see Erickson and Whited, 2000), in the estimation of the expected level of investment, we include the sales growth additionally to Tobin's Q. We find that the results do not change after the extension of the model.

investment level. We use the residual as a firm-specific proxy for investment inefficiency. A positive residual (i.e., a positive deviation from the expected investment) indicates overinvestment, a form of investment inefficiency when a firm makes investment at a higher rate than the expected level. In contrast, a negative residual (i.e., a negative deviation from the expected investment) indicates underinvestment, a form of investment inefficiency when a firm makes investment at a lower rate than the expected level.

We then construct the variable indicating underinvestment. $Underinvestment$ is measured by the absolute value of the negative residuals of the above model. The higher value of which suggests the greater deviation from the predicted investment level, and, as a result, the more severe underinvestment. We use $Underinvestment$ as a dependent variable in the further analysis examining individual and joint effects of the commitment mechanisms on investment inefficiency:

$$Underinvestment_{i,t} = \beta_0 + \beta_1 Commit\,Mechanism_{i,t-1} + \beta_2\,Controls_{i,t-1} + \epsilon_{i,t}, \quad (4.8)$$

where $Commit\,Mechanism$ defines either as an indicator of CDS trading activity (*CDS Active*), or an aggregated measure of strictness of financial covenants included in a loan at the loan inception (*FinCov*). The positive (negative) sign of β_1 indicates the exacerbation (mitigation) of investment inefficiency. To test the joint effect of covenants and CDSs on investment inefficiency, we interact *FinCov* with *CDS Active*.

Motivated by prior research that use residuals as a deviation from the expected optimal investment level (Chen, Hope, Li, and Wang, 2011), we control for firm size, asset tangibility and financial slack. The definitions of these variables are presented in Appendix 4.A1. The model is estimated using firm and time (calendar quarter - year) fixed effects. Standard errors are robust to heteroskedasticity and clustered at the firm level.

The results are reported in Table 4.11. We find that, unlike covenants, CDSs do not improve, but worsen investment efficiency for the average firm through enhancing underinvestment. The coefficient estimate for *CDS Active* is positive and statistically significant at the 1% level. The covenant mitigation effect persists after addressing potential endogeneity by the instrumental variable approach. The test on the joint effect of the two commitment mechanisms on investment inefficiency indicates that financial covenants loose their ability to mitigate underinvestment following the introduction of CDS trading. The coefficients of the interaction term *FinCov* $\times$ *CDS Active* are positive and statistically significant at the 5% level in both the OLS and the second stage of IV/2SLS. [20] Overall, the results of robustness check on the alternative measure of investment inefficiency remain broadly consistent with our foregoing analysis.

Table 4.11: **Commitment mechanisms and investment inefficiency.** This table presents the coefficients and robust standard errors clustered by firm, that are obtained from the panel regressions analysing individual and joint effects of commitment mechanisms on investment inefficiency based on equation (4.8). The dependent variable, *Underinvestment*, represents a deviation from the optimal investment level estimated based on firm's growth opportunities cross-sectionally for each industry-quarter in (4.7), and measured by absolute value of its negative residuals. The positive (negative) sign of *CDS Active/FinCov* indicates the exacerbation (mitigation) of investment inefficiency. The definitions of variables are presented in Appendix 4.A1. All specifications include firm and time (calendar quarter - year) fixed effects. The symbols ***, **, and * denote significance levels of 1%, 5%, and 10%, respectively.

	(1)	(2)	(3)
Panel A: OLS			
FinCov × CDS Active			0.011^{**}
			(0.005)
CDS Active	0.007^{***}		-0.008^{**}
	(0.001)		(0.004)
FinCov		-0.004^{*}	-0.007^{***}
		(0.002)	(0.002)
Size	-0.009^{***}	-0.005^{***}	-0.005^{***}
	(0.000)	(0.002)	(0.002)
Tangibility	0.005^{***}	0.005	0.005
	(0.002)	(0.011)	(0.011)
Financial slack	0.031^{***}	0.022	0.021
	(0.001)	(0.014)	(0.014)
Firm FE	YES	YES	YES
Time FE	YES	YES	YES
Observations	97,754	2,215	2,215
R-squared	0.493	0.731	0.733
Panel B: Instrumented covenant strictness			
FinCov × CDS Active			0.014^{**}
			(0.006)
FinCov		-0.007^{**}	-0.009^{**}
		(0.004)	(0.005)
Controls		YES	YES
Firm FE		YES	YES
Time FE		YES	YES
Observations		1,187	1,187

[20] In untabulated results, as a robustness check, we drop firms in the bottom decile of the *Underinvestment* variable, i.e. firms with the lowest deviation from the expected optimal level, which are more likely to be affected by measurement error in the investment model and be a subject of misclassification. The results remain unchanged.

4.7. Conclusion

In this chapter, to understand the CDS effect on financial contracting, we take a step further and test empirically the theoretical predictions developed in Chapter 3.

Based on the sample of U.S. private loans, we find strong empirical support for the comparative statics predictions in Chapter 3. Unlike covenants, CDSs do not alleviate, but enhance investment distortions created by debt overhang. The investment-distortion effect of CDSs is more prominent for firms with the higher probability to be forced by empty creditors into a liquidation, such as for the higher amount of CDS insurance written on firms and/or the weaker firms' fundamentals. Further analysis reveals that, in the post - CDS inception, covenants lose their effectiveness as a mechanism against no-commitment. The CDS market undermines shareholders' incentive to undertake valuable investment despite the presence of strict financial covenants in a loan contract. These results are robust to alternative variable measures, and address potential endogeneity issues.

Taken together, Chapters 3 and 4 shed new light on the effect of CDSs on financial contracting, and can be useful for regulators in policy discussion with respect to the welfare effects of the CDS market. Our findings indicate that the access of debt holders to credit insurance can reduce their incentive to impose covenants on loan agreements. However, the reason of this reduced incentive lies not in the substitutive effect of the CDS market, as suggested in Shan, Tang, and Winton (2019), rather in its detrimental effect on covenant effectiveness. Our findings are not inconsistent with Shan, Tang, and Winton (2019) or with other empirical papers on covenants and CDSs, but they provide a new explanation for why covenants have become looser following CDS trading.

4.8. Appendix

Appendix A: Tables

Table 4.A1: **Variable definitions**

Variable	Description
CDS variables	
CDS Active	Binary variable that equals one in and after the quarter of inception of CDS trading on a reference firm's debt. *Source: CreditTrade, GFI, Markit*
CDS Firm	Binary variable that equals one if a firm has CDS trading on its debt at any time during the sample period. *Source: CreditTrade, GFI, Markit*
PostBigBang	Indicator variable that equals one after the introduction of the Big Bang Protocol (April 4, 2009). *Source: Internation Swaps and Derivatives Association (ISDA)*
Likelihood of empty creditor threat	
Hedge Ratio	Proxy for the aggregated hedge ratio of lenders in the CDS market, h. Ratio of CDS net notional amount at the quarter-end scaled by the total debt. *Source: DTCC, Compustat*
Firm Stability	An empirical measure of firm financial stability, which closely corresponds to the model's parameter H. Calculated as a composite score measure based on the average of decile-sorted key partitions variables of H: leverage, firm productivity (Tobin's Q) and liquidation costs (nonfixed assets). Where leverage and liquidation costs are corrected through multiplication by minus one before sorting so that H is increasing in all variables. *Source: Compustat*
Financial covenant	
FinCov	Proxy for the covenant strictness, $c*$. Overall measure of debt covenant strictness calculated as the aggregate probability of covenant violation at the loan inception date across all financial covenants included on a given loan package from the total set of fifteen covenant categories in Dealscan. The calculation is based on a non-parametric simulation approach by Demerjian and Owens (2016). *Source: Compustat, DealScan*
# covenants	Number of financial covenants included on a loan package at the loan inception from the total set of fifteen covenant categories in Dealscan. *Source: DealScan*
Covenant definitions	For each 15 financial covenant documented in Dealscan, we use "standard" definitions (including Compustat implementations) determined by Demerjian and Owens (2016): (1) Min. Cash Interest Coverage = EBITDA/Interest Paid ($oibdpq/intpny$), (2) Min. Debt Service Coverage = EBITDA/(Interest Expense + Principal) ($oibdpq/(xintq + lag(dlcq))$), (3) Min. EBITDA = EBITDA ($oibdpq$), (4) Min. Fixed Charge Coverage = EBITDA/(Interest Expense + Principal + Rent Expense) ($oibdpq/(xintq + lag(dlcq) + xrent)$),

Table 4.A1 **- Continued**

Variable	Description
	(5) Min. Interest Coverage = EBITDA/Interest Expense ($oibdpq/xintq$), (6) Max. Debt-to-EBITDA = Debt/EBITDA ($(dlttq + dlcq)/oibdpq$), (7) Max. Senior Debt-to-EBITDA = Senior Debt/EBITDA ($(dlttq + dlcq - ds)/oibdpq$), (8) Min. Quick Ratio = (Account Receivable + Cash and Equivalents)/Current Liabilities ($(rectq + cheq)/lctq$), (9) Min. Current Ratio = Current Assets/Current Liabilities ($actq/lctq$), (10) Max. Debt-to-Equity = Debt/NW ($(dlttq + dlcq)/(atq - ltq)$), (11) Max. Debt-to-Tangible Net Worth = Debt/TNW ($(dlttq + dlcq)/(atq - intanq - ltq)$), (12) Max. Leverage = Debt/Assets ($(dlttq + dlcq)/atq$), (13) Max. Senior Leverage = Senior Debt/Assets ($(dlttq + dlcq - ds)/atq$), (14) Min. Net Worth = NW ($atq - ltq$), (15) Min. Tangible Net Worth = TNW ($atq - intanq - ltq$).
% performance covenants	Percentage of performance covenants included on a loan package at the loan inception. Based on covenant definitions: # (1) - (7). *Source: DealScan*
% capital covenants	Percentage of capital covenants included on a loan package at the loan inception. Based on covenant definitions: # (8) - (15). *Source: DealScan*
FinCov	Financial covenant strictness instrumented by the number of defaults on lead lenders' loan portfolios in 90 days prior to contracting of a new loan. *Source: DealScan, Compustat*
Default 90 days	Number of outstanding loan packages in loan portfolios of lead lenders that defaulted (i.e., for which the borrower's rating was changed to *Default* or *Selective Default* based on S&P rating database) 90 days prior contracting date. *Source: DealScan, Compustat*
Contracting date	90 days prior to the loan start date (legal effective date). *Source: DealScan*
Agency costs measures	
Debt Overhang	Empirical measure of debt overhang (e.g., see Hennessy, Levy, and Whited, 2007). $$Overhang_{i,t} = \frac{D_{i,t}}{K_{i,t}} RecoveryRatio \left[\sum_{s=1}^{20} \rho_{t+s} [1 - 0.05(s-1)](1+r)^{-s} \right]$$ where D is the firm's total debt, K is the firm's capital stock, $Recovery\,Rate$ is an industry specific weighted recovery ratio of defaulted senior unsecured bonds by three-digit SIC code, ρ is the firms' default probability calculated as the expected default frequency (EDF) following the approach of Bharath and Shumway (2008), r is a risk-free rate based on long-term Treasuries. *Source: Compustat, CRSP, Altman and Kishore (1996) for recovery ratios, Federal Reserve Bank Reports*

Table 4.A1 **- Continued**

Variable	Description
Underinvestment	Measure of investment inefficiency determined based on the absolute value of the negative residuals of the cross-sectional estimation of the parsimonious expected investment model based on firms' growth opportunities for each industry-quarter (with at least 30 observations). $$Investment_{i,t} = \beta_0 + \beta_1 TobinQ_{i,t-1} + \epsilon_{i,t},$$ The higher value, the more severe underinvestment (i.e., greater deviation from the predicted investment level). *Source: Compustat*
Firm characteristics	
Investment	Capital expenditures normalized by the start-of-period Net PPE, $capxy/ppentq(t-1)$, where $capxy$ is adjusted for fiscal quarter accumulation. *Source: Compustat*
Cash Flow	Internal cash flow normalized by the start-of-period Net PPE, $(ibq + dpq)/ppentq(t-1)$. *Source: Compustat*
TobinQ	Tobin's q defined as market value of assets divided to book value of assets, $(prccq \times cshoq + atq - ceqq)/atq$. *Source: Compustat*
Altman	Altman's Z-score defined as $3.3 \times piq/atq + saleq/atq + 1.4 \times req/atq + 1.2 \times (actq - lctq)/atq$. *Source: Compustat*
Rating dummies	Dummy variable for a firm's S&P long-term debt rating. *Source: Compustat*
Investment grade	Indicator variable equal to one if a firm has investment grade rating (i.e., BBB or above). *Source: Compustat*
Leverage	Total debt to book value of assets, $(dlcq + dltq)/atq$. *Source: Compustat*
Cash flow volatility	Cash flow $(ibq + dpq)$ standard deviation for the previous ten years. *Source: Compustat*
Size	Natural logarithm of a firm's total assets, defined as atq. *Source: Compustat*
Tangibility	Net PPE scaled by total assets, $ppentq/atq$. *Source: Compustat*
Financial slack	Cash to total assets, $cheq/atq$. *Source: Compustat*
Loan characteristics	
Loan amount	Sum of loans (i.e., facilities, tranches) included in the loan package. *Source: DealScan*
Loan maturity	Weighted average of maturities of loans included in the loan package where the weights are the amount of each loan. *Source: DealScan*
# participants	Number of lenders in the loan syndicate. *Source: DealScan*
# lead lenders	Number of lead lenders in the loan syndicate. *Source: DealScan*
Loan spread	The weighted average of all-in-drawn loan spreads over LIBOR at the loan inception where the amount of each loan is used as loan weights. *Source: DealScan*
Secured	Binary variable that equals one if there are secured loans in the package. *Source: DealScan*
Purpose	Binary variable that equals one if the loan is issued for corporate (or refinancing, or acquisition, or backup line) purposes. *Source: DealScan*
Renegotiation frictions proxy	
Short-term debt	$dlcq/(dlttq + dlcq)$. Empirical proxy is determined following the extant literature (e.g., see Davydenko and Strebulaev, 2007). *Source: Compustat*

Table 4.A1 **- Continued**

Variable	Description
Norm no. of shareholders	Log(Number of institutional shareholders/Market equity). Empirical proxy is determined following the extant literature (e.g., see Davydenko and Strebulaev, 2007). *Source: Thomson 13f, Compustat*
Shareholder bargaining power proxy	
Institutional ownership	Percentage of total equity owned by institutional investors. Empirical proxy is determined following the extant literature (e.g., see Davydenko and Strebulaev, 2007). *Source: Thomson 13f*
Liquidation costs proxy	
Nonfixed assets	1-Net PPE/Book total assets, $1 - ppentq/atq$. Empirical proxy is determined following the extant literature (e.g., see Davydenko and Strebulaev, 2007). *Source: Compustat*
Intangibles	1 - (Cash + 0.715 x Receivables + 0.547 x Inventories + 0.535 x Net PPE)/Total assets, $1 - (chq + 0.715 \times rectq + 0.547 \times invtq + 0.535 \times ppentq)/atq$. Empirical proxy is determined following the extant literature (e.g., see Favara, Schroth, and Valta, 2012). *Source: Compustat*

Appendix B: Simulation approach

To calculate the measure of debt covenant strictness *FinCov*, we follow the non-parametric simulation approach by Demerjian and Owens (2016). The goal of this simulation is to compute the aggregate probability that at least one financial covenant attached to a debt contract will be violated during the quarter after the loan inception. The computation is organized in the following steps:

1. Based on Compustat data, for all levered firms we calculate financial ratios associated with all 15 financial covenants documented in Dealscan based on "standard" debt covenant definitions provided by Demerjian and Owens (2016). Note, that we focus on the firm's most recent quarterly data preceding the loan origination date. The list of these 15 covenants, their standard definitions and Compustat implementations are detailed in Appendix 4.A1.
2. For each firm-quarter, we then calculate quarterly changes for each 15 financial underlying ratios from Step 1. Changes are presented in the ratio form, i.e. $Change_t = FinRatio_t / FinRatio_{t-1}$, where t is a fiscal quarter. The financial ratio increases if $Change > 1$, and decreases if $Change \in (0,1)$. Observations

with missing data on changes for any of the 15 financial ratios are deleted. The rest change variables are truncated at the upper and lower percentiles.

3. Next, firms are sorted into 12 size-profitability bins. Specifically, we first sort firm-quarter observations into size quartiles, and next into profitability terciles. Size is measured by average total assets. Profitability is measured by ROA (operating income before depreciation scaled by average total assets).
4. For each 15 financial underlying ratios, we then simulate the firm's one-quarter-ahead measures. To do it, we multiply the firm's quarterly financial underlying ratios by change variables (from Step 2) in the randomly drawn match firm observation (i.e., from the sample of firms in the same size-profitability bin).
5. Then, we compare the forecasted (simulated) financial underlying ratios with the initial covenant thresholds in Dealscan, and record whether there is a covenant violation.
6. We repeat 1,000 times Step 4 and Step 5. In each iteration, we randomly draw (with replacement) a new firm-quarter observation matching by the size-profitability bin.
7. Finally, we calculate *FinCov* as the number of iterations with an indicated violation of any included covenant divided by 1,000.

Chapter 5

Concluding Remarks

The thesis contributes to the ongoing debates on the welfare effects of the CDS market by revealing positive and negative effects which were previously undetected.

Chapter 2 provides the first comprehensive assessment of the effect of CDSs on human capital representing one of the key non-financial stakeholders of firms. We find that the inception of CDS trading on borrowers' debt leads to an increase in employee pay and an improvement of overall labor welfare, including broad-based cash profit sharing and health and safety benefits. Our findings of the CDS effect on human capital, an asset which brings essential economic value to the firm's business and the economy as a whole, add positively to the ongoing debates on the welfare effects of the CDS market. Furthermore, the study helps to improve our understanding of determinants of corporate labor relationship and emphasizes the role of credit derivatives in shaping corporate human-resource policies.

Chapters 3 and 4 shed new light on the effect of CDSs on financial contracting, and provide an explanation to current empirical research. To the best of our knowledge, we are the first who theoretically investigate whether the emergence of the CDS market changes creditors' incentive to use traditional tools of financial contracting, such as debt covenants, for protection of their interests. Our analysis is built on understanding whether CDS contracts can be considered as an adequate substitute for debt covenants, and whether the presence of CDS trading changes their effectiveness as a countervailing force against no-commitment. Based on the sample of U.S. private loans, Chapter 4 provides empirical support for the theoretical predictions developed in Chapter 3.

Our findings indicate that the access of debt holders to credit insurance can reduce their incentive to impose covenants on loan agreements, that is consistent with empirical findings of weakened covenant strictness post CDS inception by Shan, Tang, and Winton (2019). However, the reason of this reduced incentive lies not in the substitutive effect of the CDS market, as suggested in Shan, Tang, and Winton (2019), rather in its detrimental effect on covenant effectiveness. That also provides an explanation to empirical findings of Chakraborty, Chava, and Ganduri (2015), who document no creditors' intervention in investment policies in CDS traded firms, including those with agency problems, following covenant violations. Thus, the loss of covenant effectiveness post CDS inception can be much broader, and be also related to its ex post disciplining effect on corporate policies following technical default.

While the thesis was being prepared for final submission, a new paper-discussion by Demerjian (2019) came to our attention. The paper provides a discussion of aspects, which are important for understanding and interpreting findings of Shan, Tang, and Winton (2019). In particular, Demerjian (2019) raises a question of whether weakened loan provisions in CDS firms could be associated with an improved contracting efficiency and a substitution of loan contractual protection. He argues that CDSs may or may not be a substitute for traditional tools of financial contracting, and a negative correlation observed empirically between these instruments might be not due to the substitution effect. Given the complexity of the problem, he highlights the importance of understanding the full nature of risk that CDSs and covenants address. This thesis answers the questions raised by Demerjian (2019).

Finally, our findings of the detrimental CDS effect on traditional tools of financial contracting, used by creditors to reduce debt-equity agency conflicts, add negatively to the ongoing debates on the welfare effects of the CDS market. Notwithstanding the potential loss of covenant effectiveness post CDS inception, debt holders should be particularly careful in loosening covenant strictness given its complementary value in reducing the likelihood of strategic debt service and inefficient liquidation caused by CDS-protected empty creditors.

Findings in this thesis could inspire future research on various topics. First, Chapter 2, recognizing the interaction between financial innovations and human capital of firms, opens a new and exciting path for future research in corporate human-resource policies. Chapters 3 and 4 suggest further studies to take into account that the joint use of several commitment mechanisms does not always lead to an improvement of contracting efficiency, and instead may have an opposite effect. Finally, a natural progression of Chapter 4 is to empirically examine changes in covenant effectiveness post CDS inception in public bond market.

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